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PB-267 216

Report of Baseline Water Quality Investigations on the White River in Western Colorado, September-October, 1975, and May-June, 1976

Environmental Protection Agency, Denver, Colo

May 77

PB 267 216

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SPRINGFIELD, VA. 22161

EPA-908/2-77-001

REPORT OF BASELINE WATER QUALITY INVESTIGATIONS ON THE WHITE RIVER IN WESTERN COLORADO SEPTEMBER - OCTOBER, 1975 AND MAY - JUNE, 1976

by

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TECHNICAL INVESTIGATIONS BRANCH
SURVEILLANCE AND ANALYSIS DIVISION
U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION VIII

MAY, 1977

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ACKNOWLEDGEMENTS

The stream flow data provided by the U.S. Geological Survey comprises an important part of this report. Grateful acknowledgement is due Mr. Vernon W. Norman and his staff in the Meeker Subdistrict Office of the U.S.G.S. for their assistance in supplying this important data.

The author also wishes to acknowledge the useful work of the consulting firm Nelson, Haley, Patterson, Quirk, Inc. in its development of several helpful documents on water quality in the study area for the Colorado West Area Council of Governments. These documents contributed substantially in the effort of analyzing the water quality data collected during this study.

The large amount of chemical data presented herein could not have been produced without the cooperation of the staff of the Laboratory Services Section of the EPA Technical Investigations Branch. Acknowledgement for the long hours of analytical work is hereby given.

This project was conducted under the supervision and direction of C.E. Runas, Chief, Water Quality Investigations Section. Field work was conducted by C.E. Runas, William A. Warner, and Robert L. Fox.

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-908/2-77-001	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Report of Baseline Water Quality Investigations on the White River in Western Colorado September - October, 1975 and May - June, 1976		5. REPORT DATE 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Robert L. Fox		8. PERFORMING ORGANIZATION REPORT NO. S&A/TIB-31
9. PERFORMING ORGANIZATION NAME AND ADDRESS Technical Investigations Branch Surveillance & Analysis Division U.S. Environmental Protection Agency, Region VIII Denver, Colorado		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Same as Box 9		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE 908/00

15. SUPPLEMENTARY NOTES

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Pollution parameter values exceeding recommended criteria and/or proposed stream standards were found at several locations, with the largest number of violations occurring in the downstream reach of the White River between Meeker and Rangely, Colorado. Excessive concentrations of several parameters were also measured in three White River tributary streams - Yellow Creek, Coal Creek, and Little Beaver Creek. The parameters most frequently in violation included TDS, TSS, total iron, total zinc, and total phosphorus. There was no clear indication that either the lower or higher flow rates produced the greater number of pollution problems.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT Release to the Public	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 98
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE PCA05-A01

EPA Form 2220-1 (9-73)

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CONVERSION FACTORS

Kilometers x 0.6214	=	miles
Meters x 3.281	=	feet
Liters x 0.946	=	quarts
Cubic meters/sec (m^3/s) x 35.315	=	cubic feet/sec (cfs)
Kilograms x 2.205	=	pounds
Metric tons x 2205	=	pounds

INTRODUCTION

The Bureau of Reclamation has initiated a comprehensive study of the White River in Western Colorado to develop information relative to the Yellow Jacket Project, a proposed multi-purpose water development project for irrigation, municipal, industrial, and energy-related water uses (BOR, 1968). This development must be accomplished within an environmentally-sound framework, which requires that the existing baseline environmental conditions be determined prior to any major development activity.

The environmental studies initially planned by the Bureau of Reclamation focused primarily on biological investigations, both aquatic and terrestrial. These studies were contracted with the Colorado Division of Wildlife (Burkhard, 1976). In order to complement the aquatic biological study, and produce a more comprehensive appraisal of existing stream characteristics, the Region VIII EPA office in Denver was asked to conduct an intensive water quality investigation concurrently with the Colorado Division of Wildlife study.

The purpose of the study was to document the current baseline conditions of water quality present in the White River during both "low flow" and "high flow" periods. This report presents the results of those studies conducted during the Fall of 1975 and the Spring of 1976.

SUMMARY AND CONCLUSIONS

The Grand Junction office of the Bureau of Reclamation requested that EPA provide technical assistance in the form of baseline physical and chemical water quality data for the White River drainage and Milk Creek in Western Colorado to be used in evaluating potential impacts from a proposed multi-purpose water development project. In fulfillment of that request EPA conducted water quality studies on 200 km (125 mi) of the White River plus selected tributaries and Milk Creek during a "low flow" period in the Fall of 1975 and during a "high flow" period in the Spring of 1976.

Stream flows during the two studies were considered to be representative of average "low flow" and "high flow" conditions. "High" flows were as much as ten times greater than "low" flows at some locations.

Because the two studies were essentially "baseline" investigations, all results were compared with recommended criteria and/or proposed stream standards (criteria/standards) to identify existing or potential water quality problems. The selected criteria/standard values were the most restrictive levels specified for the protection of various water uses, such as drinking water supply, aquatic life/wildlife, irrigation, and livestock. Although sampling in the lower portion of the White River drainage (particularly near Rangely) indicated numerous violations of criteria/standards, the upper drainage (upstream from Meeker) contained water that, with few exceptions, was of generally high quality.

Most of the problems identified in the mainstem White River, including the North Fork, occurred at the furthest downstream station at Rangely, Colorado at RM 78.2. Values exceeding the criteria/standards were observed for TDS (557 mg/l), TSS (620 mg/l), aluminum (9780 mg/l), iron (12500 mg/l), copper (20 µg/l), manganese (295 µg/l), zinc (75 µg/l) and total phosphorus (0.630 mg/l as P). All of the mainstem stations between Meeker and Rangely also contained concentrations of TSS, iron, and total phosphorus in excess of the criteria/standards. In the upper White River drainage between Meeker and Trappers Lake, only iron and zinc concentrations were measured in excess of the criteria/standards, with zinc occurring in greater concentrations near the headwaters than in the downstream area. Of the various parameters discussed above, only TDS and total phosphorus concentrations were considered to be directly influenced by man's activities in the drainage area. These two parameters exceeded the criteria/standards, at least partially, because of return flows from irrigated lands bordering the White River. If impoundments of water are planned in the lower White River basin, the algal growth potential of the nutrient-rich water should be evaluated by conducting algal assays.

Of the six tributary streams sampled during these studies, Yellow Creek contained numerous parameters in excess of recommended criteria/standards, including dissolved oxygen (4 mg/l), alkalinity (1589 mg/l as $CaCO_3$), TDS (2710 mg/l), TSS (91 mg/l), sodium (868 mg/l), iron (1750 µg/l),

molybdenum (45 µg/l), selenium (16 µg/l), boron (1025 µg/l), and fluoride (2.34 mg/l). Other tributaries containing excessive parameter concentrations include the following: Little Beaver Creek (TDS- 752 mg/l, TSS- 52 mg/l, iron- 1200 µg/l, selenium- 25 µg/l, and total phosphorus- 0.419 mg/l as P), Coal Creek (TSS-203 mg/l, iron- 4700 µg/l, and total phosphorus- 0.250 mg/l as P), Miller Creek (TDS- 728 mg/l), Big Beaver Creek (TDS- 527 mg/l), and Lost Creek (iron- 560 µg/l and zinc- 80 µg/l). Except for irrigation return flows contributing TDS and phosphorus in Coal Creek, Miller Creek, and Little Beaver Creek, these excessive parameter concentrations all appear to be due to natural hydrochemical stream characteristics.

The South Fork of the White River was found to be of very high quality except for slightly high concentrations of zinc (70 µg/l) due to natural causes.

The Milk Creek drainage, located approximately 30 km (19 mi) northeast of Meeker, is the site for a proposed reservoir development. Samples were collected upstream and downstream from the proposed reservoir, and the following parameters were measured at concentrations in excess of recommended criteria/standards: TDS (1115 mg/l), TSS (210 mg/l), and total phosphorus (0.183 mg/l as P). Concentrations of the common minerals (calcium, sodium, magnesium, and potassium) were also at levels indicative of highly mineralized water.

DESCRIPTION OF STUDY AREA

The White River has its headwaters near Trappers Lake in Northwest Colorado, and from this high mountain source flows westward to its junction with the Green River in Eastern Utah. The upper White River drainage is characterized by high mountain forests and scattered meadows utilized for livestock grazing. Further downstream ranching and farming practices become more intensive with the large scale use of irrigation in the river bottoms. A major tributary, the South Fork White River, flows northward from the Flattops Wilderness Area and joins the North Fork White River at Buford. From the confluence at Buford the White River flows westward through Rio Blanco County and the towns of Meeker and Rangely. Both towns are expected to undergo significant growth due to the development of coal and oil shale resources in the area. Two federal oil shale lease sites are located in the Piceance Creek drainage approximately 40 km (25 mi) southwest of Meeker, while coal development is occurring at numerous locations throughout northwestern Colorado. Piceance Creek was not sampled during these studies because it is being extensively studied by oil shale developers and the USGS.

The White River study area included a stream reach of approximately 200 km (125 mi) with nine water quality sampling stations located on the mainstem and eight stations located on tributary streams (the South Fork White River is considered a tributary for purposes of this study). These stations were located at points of reasonable access which would produce representative physical and chemical water quality data. Additional sampling was conducted at two locations on Milk Creek, a tributary of the Yampa River located approximately 30 km (19 mi) northeast of Meeker. The segment of Milk Creek sampled during these studies flows through an area of intensive farming and ranching similar to the lower White River drainage, and has been proposed as a possible future reservoir site. The station locations (and water quality parameters) were selected and approved prior to the study by representatives of the Bureau of Reclamation, Colorado Division of Wildlife, and the Environmental Protection Agency. The location of all stations is shown on the map in Fig. 1 and described in Table 1.

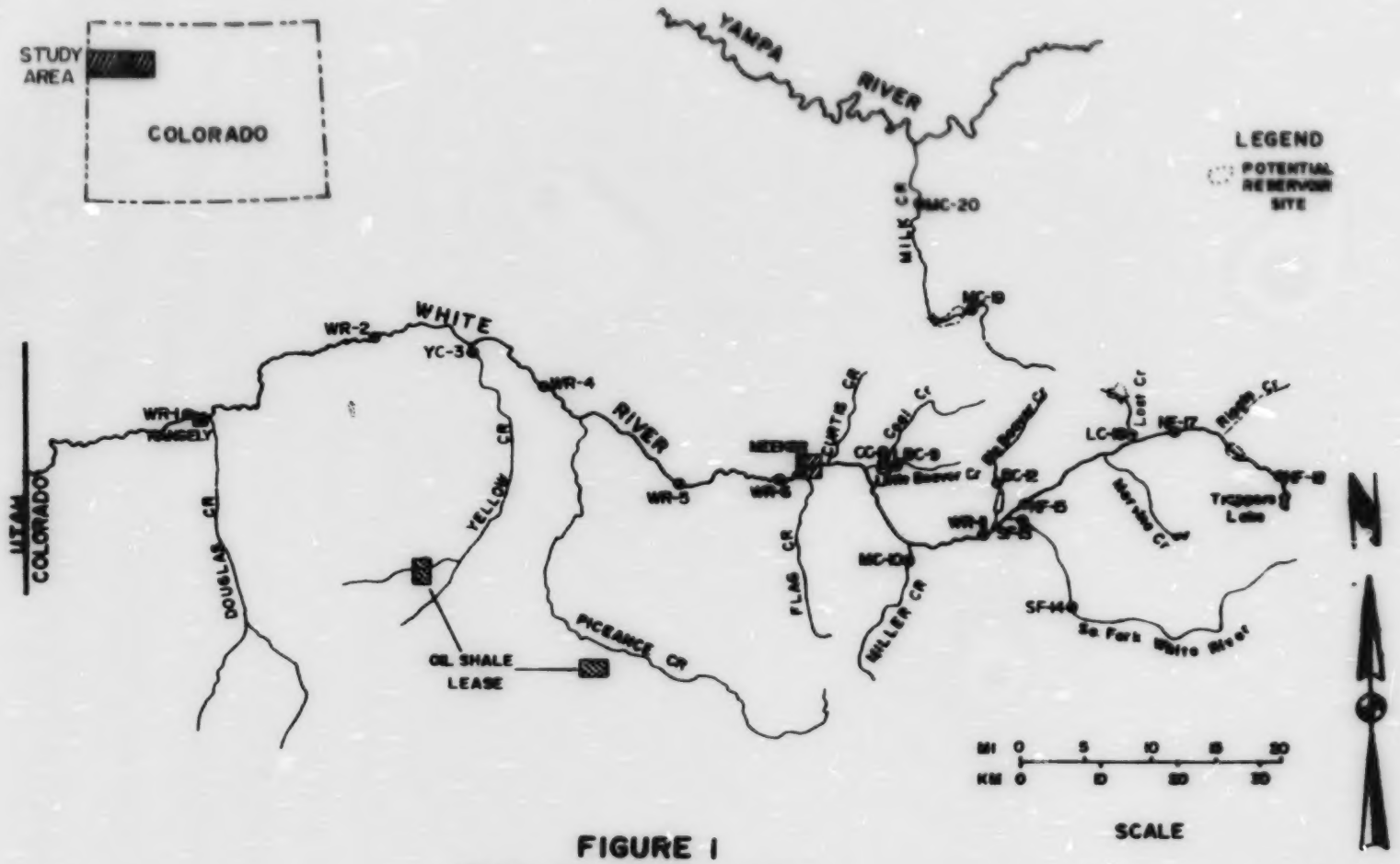


FIGURE 1
MAP OF STUDY AREA

Table 1

White River Study

Station Locations

Station No.	RM*	RK**	Description
WR-1	78.2	125.9	White River downstream from Rangely, Bridge on Hwy. 64
WR-2	100.8	162.3	White River near Angora, old steel bridge North of Hwy. 64
YC-3	111.0	178.7	Yellow Creek at gaging station, at Hwy. 64 bridge.
WR-4	116.1	186.9	White River near Blair Mesa, South bank near Hwy. 64, near Smizer Gulch
WR-5	134.1	215.9	White River at USGS gaging station near Kendall Gulch, off Hwy. 64
WR-6	144.3	232.3	White River downstream from Meeker, at Hwy. 13/789 bridge
CC-8	152.6	245.7	Coal Creek near mouth, bridge on road east off Hwy. 132
LBC-9	-	-	Little Beaver Creek near mouth, bridge on road east off Hwy. 132
MC-10	160.6	258.6	Miller Creek at USGS gaging station
WR-11	168.4	271.1	White River, immediately downstream from confluence with Big Beaver Creek, bridge off Hwy. 132
BC-12	168.6	271.4	Big Beaver Creek upstream from Avery Reservoir, at footbridge
SF-13	169.1	272.2	South Fork White River at USGS gaging station near mouth
SF-14	-	-	South Fork White River at South Fork Campground, at footbridge
NF-15	170.6	274.7	North Fork White River at Buford, bridge off Hwy. 132, upstream from Bel-air fish hatchery
LC-16	180.8	291.1	Lost Creek at USGS gaging station near mouth, bridge on Hwy. 132

Table 1 - continued

Station No.	RM	RK	Description
NF-17	187.1	301.2	North Fork White River approx. 1 mile upstream from North Fork Campground
NF-18	192.6	310.1	North Fork White River upstream from Big Fish Creek, 2 miles upstream from Himes Peak Campground
MC-19	19.6	31.6	Milk Creek at bridge located approximately 1 mile upstream from Thornburgh Historical Site
MC-20	4.8	7.7	Milk Creek near Iles Mountain, bridge on Hwy. 13/789

* River mileages were obtained from a consultants report (NHPQ, 1976b).

** River kilometers

STUDY METHODS

Water quality samples were collected from all 19 stations during both the "low flow" study in Sept.-Oct., 1975 and the "high flow" study in May-June, 1975. The 200 km (125 mi) stream reach was divided into three segments because of the long distances involved, and each segment was sampled on four consecutive days during each study. Segment I covered the lower White River, including stations 1-5, Segment II included stations 6-10 plus the two Milk Creek stations, and Segment III included the remaining stations in the upper White River drainage (Fig. 1). During the "low flow" study sampling progressed downstream from Segment III during the first week to Segment I during the third week. The sampling pattern was reversed during the following "high flow" study, with sampling occurring first in Segment I and then progressing upstream. This arrangement provided the greatest possibility for sampling at the desired flow conditions while minimizing the adverse impact of winter weather conditions.

The water quality parameters measured during this investigation are listed in Table 2. Although an attempt was made to include a wide range of parameters, it is realized that these parameters are not all-inclusive and may not satisfy the needs of everyone concerned with water quality in the White River area.

At each sampling site field measurements were made for temperature, pH, specific conductance (conductivity), and occassionally, flow. Sampling stations had been located, wherever possible, at flow measuring stations operated by the Geological Survey (GS). Mean daily flow rates from these stations were utilized in this study whenever possible. The instantaneous flows determined by EPA were obtained by standard stream gaging methods utilizing a Marsh-McBirney electromagnetic current meter with direct velocity readout.

Water samples were collected at each site for immediate analysis (within 4 hours) in the temporary field office for the following parameters: turbidity, total alkalinity, hardness, and dissolved oxygen. The dissolved oxygen samples were collected in 300 ml glass BOD bottles - all other samples were collected in 0.95 ℓ (1 qt.) polyethylene cubitainers. When required, samples were kept chilled in ice chests until analyzed. A Hach Turbidimeter with formazin liquid standards was used for the turbidity measurements. Total alkalinity was determined potentiometrically while hardness was determined by the EDTA Titrimetric method. Dissolved oxygen measurements were obtained by the Winkler titration method employing field fixing with the appropriate powder reagents.

Additional water was collected from each site for analysis for chloride, fluoride, boron, total dissolved solids (TDS), total suspended solids (TSS), and metals. The TSS samples were collected by a dip-and-take method after comparison with the recommended depth-integration method showed that in the rapidly flowing streams sampled in this study there

Table 2

Water Quality Parameters Measured

General Parameters

Flow
Temperature
pH
Dissolved Oxygen
Hardness
Alkalinity
Conductivity
Total Dissolved Solids
Total Suspended Solids
Turbidity

Common Minerals

Calcium
Magnesium
Potassium
Sodium
Chloride

Metals and Related Elements*

Aluminum
Arsenic
Cadmium
Chromium
Copper
Iron
Lead
Lithium
Manganese
Molybdenum
Selenium
Silver
Zinc

Non-Metals

Boron
Fluoride

Nutrients**

Total Kjehldal Nitrogen (TKN)
Nitritite & Nitrate Nitrogen (NO_2 + NO_3)
Ammonia Nitrogen (NH_3)
Total Phosphorus (T-P)
Ortho Phosphorus (O-P)

* All metals are "total" metals

** These nutrient parameters were measured only during the spring "high flow" study

were no apparent differences between the two methods. The samples for total metals were placed in 0.95 ℓ (1 qt.) polyethylene cubitainers, preserved with HNO_3, and transported to the EPA laboratory for analysis at the conclusion of each 4-day sampling period. On one occasion (station WR-1 on 5/26/76), water samples for dissolved metals analysis were filtered in the field using a 0.45μ membrane filter and then preserved with HNO_3.

All total metal samples were prepared by the digestion procedure established in the EPA Methods Manual (1974). After digestion, all metal analyses were performed by flame atomic absorption, except for the following variations: arsenic and selenium were determined using the graphite furnace technique with the nickel matrix modification as outlined by Ediger (1975); lead was determined in the graphite furnace with the use of ammonium nitrate to volatalize excess sodium chloride (Ediger, 1975); molybdenum was determined in the graphite furnace with no modifications; and lithium and potassium were both analyzed by flame emission spectrometry. All other parameters were analyzed according to approved procedures.

During the Spring "high flow" study water samples were collected from all stations for nutrient analysis. These grab-type samples were placed in 0.95 ℓ (1 qt.) polyethylene cubitainers, preserved with 40 mg $HgCl_2$ per liter, and held on ice until analyzed at the end of each four-day sampling period.

With the exception of TKN, all nutrient samples were analyzed using the Technicon Auto Analyzer II with the Digital Printer Module in accordance with approved methods (EPA, 1973a). The specific methods employed in the nutrient analysis were the following: ammonia- automated colorimetric phenolate; nitrite + nitrate- automated cadmium reduction; orthophosphorus- automated colorimetric ascorbic acid reduction; and total phosphorus- digestion with sulfuric acid-ammonium persulfate, followed by automated colorimetric ascorbic acid reduction.

The procedure used for TKN analysis was a semi-automated version of the standard TKN digestion and colorimetric method. The digestion procedure utilized the Technicon Block Digestor in which as many as forty samples at a time were digested under controlled conditions. The digestion converted all organic nitrogen to ammonia which was measured by the automated colorimetric phenolate method.

RESULTS OF STUDY

Introduction

An inventory of the complete set of water quality data collected during the "low flow" and "high flow" studies is presented in Appendices A and B, respectively. This large mass of raw water quality data (4940 discrete measurements) has been summarized in Table 3 to facilitate an easier and more meaningful analysis. Table 3 shows the four-day average value for each parameter measured at each sampling station during each intensive study period. These average values are shown graphically on profile maps for the White River and selected tributaries and for Milk Creek in the following section of this report. River miles are plotted as the "x" axis while parameter concentration serves as the "y" axis. Scale values may change from one profile to the next, giving the impression of a value of greater magnitude upon first viewing than is actually the case. Solid lines are used to connect the Fall "low flow" average values while dashed lines connect the Spring "high flow" values. These lines should not be interpreted as indicating the parameter concentration at any intermediate point between sampling stations.

In order to evaluate the presence of water quality problems in the study area, the data has been compared against recommended water quality criteria and proposed standards. Although the terms "criteria" and "standards" are often used interchangeably, there is an important distinction. "Criteria" are recommended parameter concentrations which, if not exceeded, will afford reasonable protection to aquatic life or designated water uses, whereas "standards" are legally-enforceable parameter limits adopted to protect unique features of specific water bodies. A more detailed explanation may be found in Quality Criteria for Water (EPA, 1976). The recommended criteria and proposed standards utilized in this report are listed in Table 4. The criteria were obtained from EPA criteria documents (EPA, 1973b; EPA, 1976) while the proposed standards were obtained from a Colorado Department of Health document (CDH, 1976). It is very important to realize that these proposed State standards are only in the development stage at this writing and may undergo change following intensive public review. The numerical values are shown here only for comparison purposes so that potential water quality problems may be identified in advance should the proposed standards be adopted. The more restrictive of the recommended criteria and proposed standards are shown, where applicable, on the water quality profile maps.

General Parameters

Flow

One of the major purposes of this study was to collect water samples during both "low flow" and "high flow" periods. In order to determine

Table 3

Comparison of Physical and Chemical Data From the Low Flow (Fall, 1975) and High Flow (Spring, 1976) Studies of the White River in Western Colorado

Parameter	Units	WR-1		WR-2		YC-3		WR-4		WR-5	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Temp.	°C	11.5	13.0	10.5	12.5	10.5	18.0	10.5	12.0	9.5	11.0
pH[2]	SU	8.1	7.3	8.1	7.1	8.7	8.6	8.0	7.6	7.8	7.5
Flow	m^3/s	13.31	45.42	13.31	43.89	0.034	0.045	13.59	45.39	13.02	44.97
DO	mg/ℓ	9.2	8.5	9.8	8.7	3.8	4.0	9.5	8.9	10.3	9.2
Conduct.	umhos/cm	760	430	790	410	3800	4150	730	400	630	350
Turbidity	FTU	17	151	9.4	59	40	29	7.9	48	5.1	26
Alkalinity	mg/ℓ as $CaCO_3$	175	146	183	122	1530	1589	175	119	142	106
Hardness	mg/ℓ	254	169	265	156	530	566	253	157	235	145
TDS	mg/ℓ	557	235	468	217	2680	2710	458	251	402	212
TDS	Metric Tons/Day	640	922	538	823	7.9	10.9	538	984	452	824
TSS	mg/ℓ	45	620	30	172	91	78	23	121	14	76
TSS	Metric Tons/Day	52	2432	37	652	0.3	0.3	27	474	15	295
Tot. Chloride	mg/ℓ	29	11	28	11	139	151	27	10	26	9.2
Tot. Fluoride	mg/ℓ	0.30	0.15	0.28	0.14	1.85	2.34	0.30	0.14	0.28	0.11
Tot. Arsenic	µg/ℓ	<5	<10	<5	<5	<5	10	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	1250	9780	810	3545	2560	1700	560	2850	550	1800
Tot. Boron	µg/ℓ	210	170	120	110	720	1025	250	120	300	115
Tot. Cadmium	µg/ℓ	<5	10	<5	<7	<5	12	<5	<6	<5	8
Tot. Calcium	µg/ℓ	58000	31500	58000	27500	20000	19000	59000	27500	60000	26000
Tot. Chromium	µg/ℓ	<15	<15	<10	<10	<10	<10	<15	<10	<10	<10
Tot. Copper	µg/ℓ	<8	20	6	10	7	10	<6	<10	<5	<10
Tot. Iron	µg/ℓ	1020	12500	760	3800	1750	1200	620	2800	420	1950
Tot. Lead	µg/ℓ	<5	10	<5	<5	<5	<5	<5	<5	<5	<5
Tot. Lithium[3]	µg/ℓ	25[4]	25	<25	15	130	220	<25	15	<25	10
Tot. Magnesium	µg/ℓ	23000	19000	22000	13000	108000	139000	23000	12000	17000	10200
Tot. Manganese	µg/ℓ	49[4]	295	28	95	45	30	28	45	28	45
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10	45	25	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	2400	4200	2100	2100	5800	12000	2000	1900	2100	1600
Tot. Selenium	µg/ℓ	<5	<5	<5	<5	16	<5	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	5	<5	5	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	48000	20000	44000	17500	868000	754000	42000	16000	23000	9000
Tot. Zinc	µg/ℓ	25	75	70	45	50	5	40	<25	25	<10
TKN	mg/ℓ	-	1.93	-	0.86	-	1.92	-	0.68	-	0.78
NO_2 + NO_3 - N	mg/ℓ	-	0.18	-	0.14	-	0.17	-	0.12	-	0.12
NH_3 - N	mg/ℓ	-	0.01	-	0.02	-	<0.02	-	0.01	-	0.01
Total P	mg/ℓ	-	0.630	-	0.209	-	0.080	-	0.132	-	0.115
Ortho P	mg/ℓ	-	0.043	-	0.036	-	0.016	-	0.035	-	0.027
Total P	kg/day	-	1.23	-	0.39	-	<0.01	-	0.26	-	0.22

1 All values shown are 4-day arithmetic averages unless otherwise noted.
2 The pH values are logarithmic averages; all other averages are arithmetic.
3 The limit of detection for lithium was 25 µg/ℓ for the fall samples and 10 µg/ℓ for the spring samples.
4 This average concentration omits one high value thought to be spurious.

Table 3 (con't.)

Parameter	Units	WR-6		CC-8		LBC-9		MC-10		WR-11	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Temp.	°C	12.5	10.0	13.0	13.5	12.0	15.0	10.5	13.5	8.5	9.0
pH[2]	SU	7.7	7.2	7.5	7.3	7.4	7.2	7.5	7.5	7.4	7.3
Flow	m^3/s	9.06	67.96	0.45	0.48	0.091	0.136	0.59	0.54	10.48	56.01
DO	mg/ℓ	9.6	9.4	8.1	8.3	7.7	8.3	8.9	8.9	8.9	9.6
Conduct.	µmhos/cm	640	280	560	530	1000	900	980	770	370	180
Turbidity	FTU	6.4	16	12.6	75	12.2	22	3.2	2.5	2.4	4.8
Alkalinity	mg/ℓ as $CaCO_3$	154	92	144	148	204	186	184	164	107	60
Hardness	mg/ℓ	254	118	245	231	500	409	514	401	155	84
TDS	mg/ℓ	422	164	384	334	752	602	728	520	234	114
TDS	Metric Tons/Day	330	962	15	14	5.9	7.1	37	24	211	608
TSS	mg/ℓ	22	57	34	203	26	52	15	15	8.8	19
TSS	Metric Tons/Day	17	335	1.4	8.4	0.2	0.6	0.7	0.7	8.0	101
Tot. Chloride	mg/ℓ	25	7.6	3.4	6.9	12	13	1.1	1.6	<1.0	1.2
Tot. Fluoride	mg/ℓ	0.28	<0.10	<0.10	0.12	0.30	0.17	0.59	0.28	0.18	<0.10
Tot. Arsenic	µg/ℓ	<5	<5	<5	<10	<5	<10	<5	5	<10	<5
Tot. Aluminum	µg/ℓ	540	1750	880	4400	760	1050	350	300	<200	650
Tot. Boron	µg/ℓ	<180	130	130	155	<220	260	360	225	90	100
Tot. Cadmium	µg/ℓ	<5	<6	<5	6	<5	7	<5	7	<5	<7
Tot. Calcium	µg/ℓ	60000	29500	59000	53000	87000	97500	126000	122000	43000	21000
Tot. Chromium	µg/ℓ	<10	<10	<15	<10	<15	10	<15	<10	10	<10
Tot. Copper	µg/ℓ	<6	5	<8	10	8	10	<8	10	<8	<6
Tot. Iron	µg/ℓ	490	1650	840	4700	780	1200	270	280	300	650
Tot. Lead	µg/ℓ	<5	<5	<5	<5	<8	<5	<5	<5	<7	<5
Tot. Lithium[3]	µg/ℓ	<25	10	<25	25	<30	40	<25	15	<25	<10
Tot. Magnesium	µg/ℓ	19000	8600	20000	22000	46000	38000	22000	15000	10000	5800
Tot. Manganese	µg/ℓ	28	40	26	105	84	85	32	10	16	14
Tot. Molybdenum	µg/ℓ	<10	10	<10	<10	<10	<10	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	1800	1200	1800	2800	2900	4800	1100	1000	1200	700
Tot. Selenium	µg/ℓ	<5	<5	<5	<10	<15	25	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	18000	6200	9400	12000	24000	25000	3100	2000	2600	1700
Tot. Zinc	µg/ℓ	55	15	40	25	35	15	35	<5	70	10
TKN	mg/ℓ	-	0.52	-	0.90	-	1.72	-	0.29	-	0.51
$NO_2 + NO_3 - N$	mg/ℓ	-	0.10	-	0.23	-	0.71	-	0.53	-	0.06
$NH_3 - N$	mg/ℓ	-	0.01	-	0.02	-	0.03	-	0.01	-	<0.01
Total P	mg/ℓ	-	0.102	-	0.250	-	0.419	-	0.016	-	0.050
Ortho P	mg/ℓ	-	0.022	-	0.064	-	0.029	-	0.005	-	0.013
Total P	kg/day	-	0.30	-	<0.01	-	<0.01	-	<0.01	-	0.12

[2] The pH values are logarithmic averages; all other averages are arithmetic.
[3] The limit of detection for lithium was 25 µg/ℓ for the fall samples and 10 µg/ℓ for the spring samples.

Table 3 (con't.)

Parameter	Units	BC-12		SF-13		SF-14		NF-15		LC-16	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Temp.	°C	11.0	15.0	11.5	8.0	7.5	7.0	8.0	9.0	14.0	10.0
pH[2]	SU	7.5	7.3	7.3	7.2	7.2	7.1	7.2	6.9	7.5	6.8
Flow	m^3/s	0.110	0.45	3.96	35.82	3.40	34.32	6.23	21.52	0.091	0.74
DO	mg/ℓ	9.6	8.5	8.7	9.5	9.1	9.8	9.3	9.4	8.8	9.0
Conduct-	µmhos/cm	800	380	330	180	230	160	370	180	460	190
Turbidity	FTU	0.86	4.0	2.2	5.0	0.66	2.4	1.4	5.6	1.3	8.8
Alkalinity	mg/ℓ as $CaCO_3$	164	120	120	80	104	72	90	56	148	74
Hardness	mg/ℓ	377	176	141	70	101	73	149	77	186	91
TDS	mg/ℓ	527	241	208	102	142	86	233	120	291	122
TDS	Metric Tons/Day	5.0	9.1	71	316	42	255	125	223	2.3	7.8
TSS	mg/ℓ	3.2	9.2	7.8	17	2.6	7.5	7.7	23	3.3	14
TSS	Metric Tons/Day	<0.1	0.4	2.6	53	0.7	22	4.2	43	<0.1	1.0
Tot. Chloride	mg/ℓ	1.4	1.6	<1.1	1.2	<1.0	0.9	<1	1.5	<1.1	1.5
Tot. Fluoride	mg/ℓ	0.50	0.15	<0.12	<0.10	<0.14	<0.10	<0.16	<0.10	<0.14	<0.10
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5	<6	<5	<6	<5	<8	<5
Tot. Aluminum	µg/ℓ	<200	200	<300	600	<200	300	<200	750	<200	400
Tot. Boron	µg/ℓ	<120	130	110	95	80	90	90	105	140	100
Tot. Cadmium	µg/ℓ	<5	<6	<5	<6	<5	<6	<5	<6	<5	7
Tot. Calcium	µg/ℓ	93000	45000	37000	21000	22000	18000	38000	20000	48000	21000
Tot. Chromium	µg/ℓ	10	<10	10	<10	<15	<10	<15	<10	10	<10
Tot. Copper	µg/ℓ	<6	<10	<6	<5	<5	<6	8	<9	10	<9
Tot. Iron	µg/ℓ	140	310	200	600	105	250	210	810	110	560
Tot. Lead	µg/ℓ	<8	<5	<8	<5	<6	<5	<5[4]	<5	6	<5
Tot. Lithium[3]	µg/ℓ	<25	10	<25	<10	<25	<10	<25	<10	<25	<10
Tot. Magnesium	µg/ℓ	24000	11000	10400	5600	8500	5000	10200	5000	13200	4600
Tot. Manganese	µg/ℓ	28	22	17	14	10	<9	18	22	21	10
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10	10	<10
Tot. Potassium	µg/ℓ	1800	1000	1200	600	900	600	1200	900	1400	800
Tot. Selenium	µg/ℓ	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	4600	3800	2200	1800	1900	1900	2700	2500	8000	3600
Tot. Zinc	µg/ℓ	80	<15	70	<10	70	<15	60	10	80	<10
TKN	mg/ℓ	-	0.29	-	0.34	-	0.65	-	0.48	-	0.38
$NO_2 + NO_3 - N$	mg/ℓ	-	0.01	-	0.06	-	0.06	-	0.05	-	0.01
$NH_3 - N$	mg/ℓ	-	0.01	-	0.01	-	<0.01	-	0.01	-	0.01
Total P	mg/ℓ	-	0.022	-	0.052	-	0.029	-	0.065	-	0.035
Ortho P	mg/ℓ	-	0.010	-	0.012	-	0.010	-	0.018	-	0.015
Total P	kg/day	-	<0.01	-	0.08	-	0.04	-	0.06	-	<0.01

[2] The pH values are logarithmic averages; all other averages are arithmetic.
[3] The limit of detection for lithium was 25 µg/ℓ for the fall samples and 10 µg/ℓ for the spring samples.
[4] This average concentration omits one high value thought to be spurious.

Table 3 (con't.)

Parameters	Units	MF-17		MF-18		MC-19		MC-20	
		Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Temp.	°C	7.5	8.0	5.5	8.0	13.5	10.0	14.5	13.5
pH[2]	SU	7.1	6.6	7.3	6.6	7.6	6.9	7.9	7.1
Flow	m^3/s	3.68	-	0.88	6.23	0.025	1.44	0.093	0.42
DO	mg/ℓ	8.8	9.3	8.6	8.7	7.1	8.7	8.2	8.2
Conduct.	µmhos/cm	310	150	130	90	730	410	1400	620
Turbidity	FTU	5.2	4.4	0.56	1.4	24	55	4.7	78
Alkalinity	mg/ℓ as $CaCO_3$	78	47	56	40	212	129	331	172
Hardness	mg/ℓ	127	60	49	35	310	181	662	271
TDS	mg/ℓ	215	96	123	59	474	252	1115	388
TDS	Metric Tons/Day	68	-	9.1	32	1.0	32	9.0	14
TSS	mg/ℓ	21	18	2.6	5	38	128	15	210
TSS	Metric Tons/Day	6.7	-	0.2	2.7	0.1	16	0.1	7.7
Tot. Chloride	mg/ℓ	<1	1.2	<1	<1.0	5.2	3.5	<1.4	5.1
Tot. Fluoride	mg/ℓ	0.14	<0.10	<0.10	<0.1	0.23	0.12	0.56	0.16
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5	<5	<10	<5	<10
Tot. Aluminum	µg/ℓ	700	550	<200	<150	1150	2750	300	4050
Tot. Boron	µg/ℓ	90	100	60	60	240	170	<230	220
Tot. Cadmium	µg/ℓ	<5	<6	<5	<6	<5	<6	<5	6
Tot. Calcium	µg/ℓ	33000	15000	12000	8600	69000	41000	82000	60000
Tot. Chromium	µg/ℓ	<20	<10	<15	<10	<15	<10	<15	<10
Tot. Copper	µg/ℓ	7	<10	<6	<7	8	<10	<8	10
Tot. Iron	µg/ℓ	770	610	130	190	1180	3150	370	5150
Tot. Lead	µg/ℓ	7	<5	6	<5	<5	<5	<5	<5
Tot. Lithium[3]	µg/ℓ	<25	<10	<25	<10	35	20	60	35
Tot. Magnesium	µg/ℓ	8400	4000	5000	2900	25000	132000	85000	24000
Tot. Manganese	µg/ℓ	22	16	16	16	109	59	84	100
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	1200	800	1100	700	3200	2200	5200	3800
Tot. Selenium	µg/ℓ	<5	<5	<5	<5	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	2600	2600	1800	1800	20000	9800	66000	19000
Tot. Zinc	µg/ℓ	100	15	75	<10	45	30	25	30
TKN	mg/ℓ	-	0.35	-	0.89	-	0.76	-	0.77
$NO_2 + NO_3$ - N	mg/ℓ	-	0.04	-	0.06	-	0.05	-	0.09
NH_3 - N	mg/ℓ	-	<0.01	-	0.01	-	0.01	-	0.02
Total P	mg/ℓ	-	0.056	-	0.028	-	0.112	-	0.183
Ortho P	mg/ℓ	-	0.017	-	0.019	-	0.024	-	0.025
Total P	kg/day	-	-	-	0.01	-	0.01	-	<0.01

[2] The pH values are logarithmic averages; all other averages are arithmetic.
[3] The limit of detection for lithium was 25 µg/ℓ for the fall samples and 10 µg/ℓ for the spring samples.

Table 4

Recommended Water Quality Criteria and Proposed Standards

Parameter	Units	Recommended EPA Criteria (EPA, 1976)	Proposed Colorado Standards (CDH, 1976)[a]	Effective Colorado Standards (CDH, 1974)
Temperature	°C	-	20, 30	20, 32
pH	S.U.	6.5-9.0	6.5-9.0	6.0-9.0
D.O.	mg/l	-	5.0, 7.0	5.0, 6.0
Hardness	mg/l as $CaCO_3$	-	-	-
Alkalinity	mg/l as $CaCO_3$	>20[h]	-	-
TDS	mg/l	500[g]	-	-
TSS	mg/l	25-median	25[b]	-
Magnesium	mg/l	-	125	-
Sodium	mg/l	270	-	-
Chloride	mg/l	250	250	-
Aluminum	ug/l	5000[i] (EPA, 1973b)	100	-
Arsenic	ug/l	50	10	-
Cadmium[d]	ug/l	0.4	0.4	-
Chromium	ug/l	50	50	-
Copper[d]	ug/l	c	10	-
Iron	ug/l	1000	500	-
Lead[d]	ug/l	30 (EPA, 1973b)[c]	4	-
Manganese	ug/l	200	200	-
Molybdenum	ug/l	10 (EPA, 1973b)	-	-
Selenium	ug/l	10[c]	10	-
Silver[d]	ug/l	50[c]	0.1	-
Zinc[d]	ug/l	c	50	-
Boron	ug/l	750	750	-
Fluoride[e]	mg/l	2 (EPA, 1973b)	2	-
Nitrate	mg/l as N	10	4[f]	-
Total Phosphorus	mg/l as P	0.1	0.1	-

[a] The values shown are based upon the most restrictive water use and water hardness encountered in the White River study area.

[b] This concentration represents the maximum allowed due to man's activities.

[c] A 96-hour LC_{50} bioassay test is recommended in order to establish a limit for the particular water body in question.

[d] Criteria limits vary according to water hardness. The most restrictive limit for the softest water found in the White River drainage (less than 100 mg/l total hardness) is shown.

[e] Fluoride criteria for drinking water are dependent upon ambient air temperatures at the monitoring site.

[f] This value is an "alert" level only; the proposed standard is 10 mg/l.

[g] Water having concentrations of TDS in excess of the stated value may have detrimental effects when used in irrigation.

[h] Although no upper limit is recommended, concentrations in excess of 500-600 mg/l as $CaCO_3$ indicate highly mineralized water which may be unsuitable for some uses.

[i] This value applies to water used for livestock watering. Bioassay research indicates that considerably lower concentrations (<1 mg/l) may be required to protect aquatic life (Everhart and Freeman, 1973).

whether flows measured during these studies were representative of typical "low" and "high" flow periods, the measured flows were compared to the historical 7-day 10-year low and high flows at several stream gaging stations. This comparison is shown in Table 5. It is evident that neither the "low flows" nor the "high flows" measured during these studies approach the 7-day average low or high flows expected to occur once each ten years at the various stations. This indicates that the measured flows were neither extremely lower nor higher than what might be considered an average flow rate for each study period. This conclusion is supported by the fact that the recurrance interval, indicating the most probable elapsed time period before a flow similar to the measured flow occurs, averaged only slightly more than one year for both the "low flow" and "high flow" rates. If determination of baseline water quality at truly "low flow" and "high flow" conditions is desired, the recurrance interval should probably be at least ten years or more.

As shown by the profile map in Fig. 2, flows measured during the Spring, 1976 "high flow" study generally averaged from three to ten times higher than flows measured during the "low flow" study in the Fall of 1975. Exceptions to this range of flows were observed at several sampling stations located on streams affected by irrigation diversions and return flow (CC-8, LBC-9, MC-19) or by other undetermined natural hydrologic characteristics (YC-3, MC-10).

Temperature

Temperature profiles for the White River are presented in Fig. 3. The profiles show that water temperatures during the Spring runoff period averaged approximately 2° C higher than during the Fall sampling period. The colder water temperatures observed during the Fall study were simply due to colder weather present during the late September - early October sampling period. Past records show that the warmest stream temperatures are usually recorded during July, August, and early September. The temperature profiles also show the gradual increase in water temperature in the downstream direction. The reason for the relatively high average temperature recorded during the Fall study at station WR-6 (RM 144.3) near Meeker is because these measurements were made during warmer weather two weeks earlier than any of the downstream measurements.

The dependence of water temperature upon the time of day during which samples were collected is also an important consideration in evaluating temperature data. For example, in Appendix A, water temperatures at WR-4 (RM 116.1) varied from 7.5° C at 0915 on 10/2/75 to 14.0° C at 1515 on 9/29/75. In summary, all of the measured water temperatures were less than the cold water criterion of 20° C during the two study periods.

pH

pH measurements were generally within the acceptable range of 6.5-9.0 standard units (S.U.) except for one measurement of 6.4 recorded at the

Table 5

Comparison of Measured Stream Flows
With Historical 7-Day, 10-Year Flows

Station Numbers		Flow, m^3/s					
EPA	USGS	7-Day, 10-Year Low Flow	Ave. Flow Fall, 1975	Recurrance Interval Years	7-Day, 10-Year High Flow	Ave. Flow Spring, 1976	Recurrance Interval Years
WR-5	09304800	5.32	13.02[1]	<1.01	96.64	44.97[1]	~1.05
WR-6	09304500	5.41	9.06[1]	1.13	108.62	67.96[1]	~1.3
SF-13	09304000	2.04	3.96[1]	<1.01	59.52	35.82[1]	~1.1
NF-15	09303000	3.17	6.23	1.01	50.94	21.52[1]	1.15
LC-16	09302450	*	0.091[1]	*	*	0.74[1]	*
MC-19	09250000	0.008	0.025[2]	2.4	10.34	1.44[3]	~1

* Insufficient data to compute 7-day, 10-year low flow

1 These values represent the 4-day average of mean daily flows recorded by the USGS on the same day that sample collection occured. These values are based upon preliminary flows only.

2 This value represents a single flow measurement made by EPA, but it is considered to be representative of flow at this location during the 4-day sampling period

3 Average of two instantaneous flow measurements made by EPA during the 4-day sampling period

FIGURE 2
FLOW PROFILE

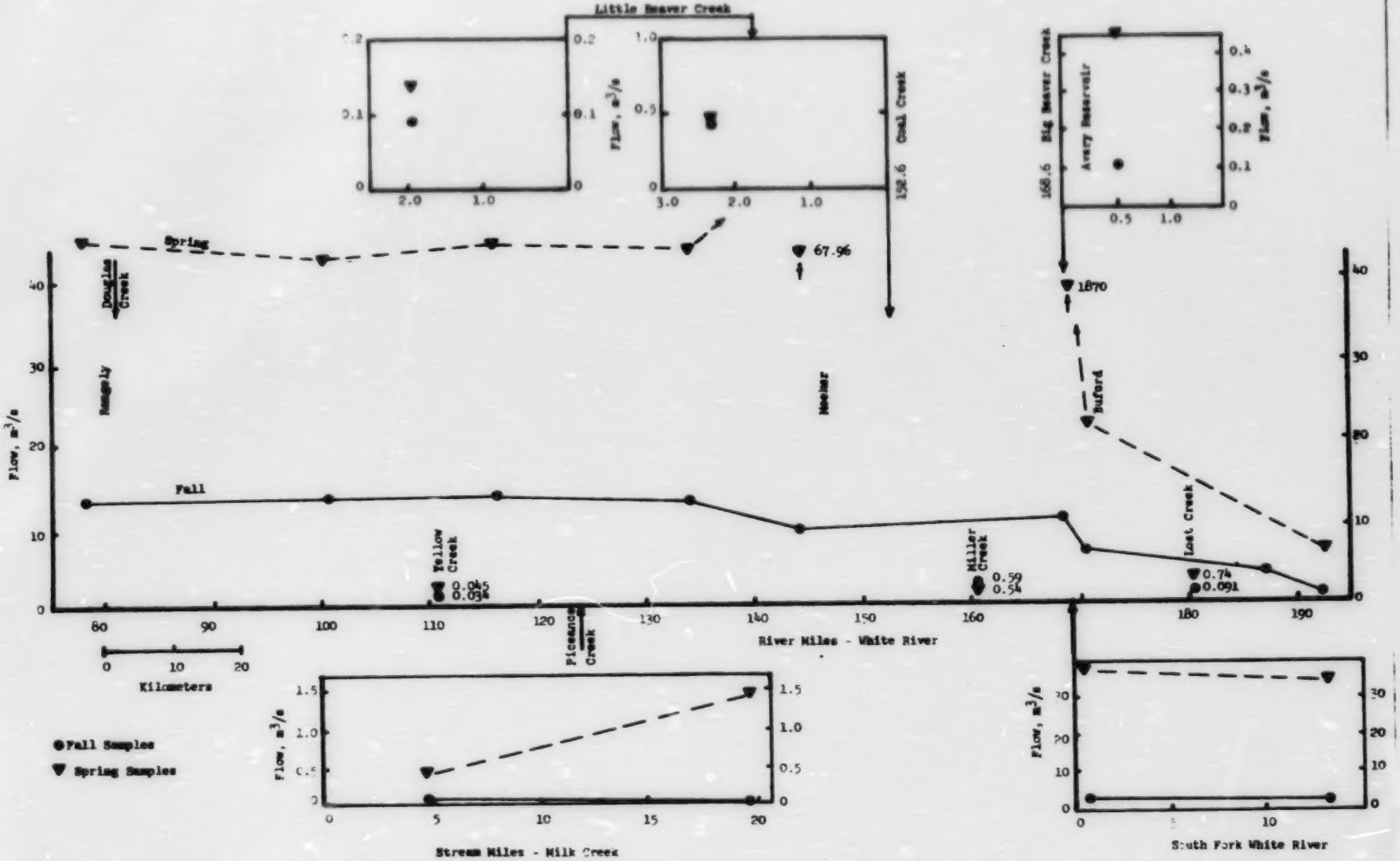
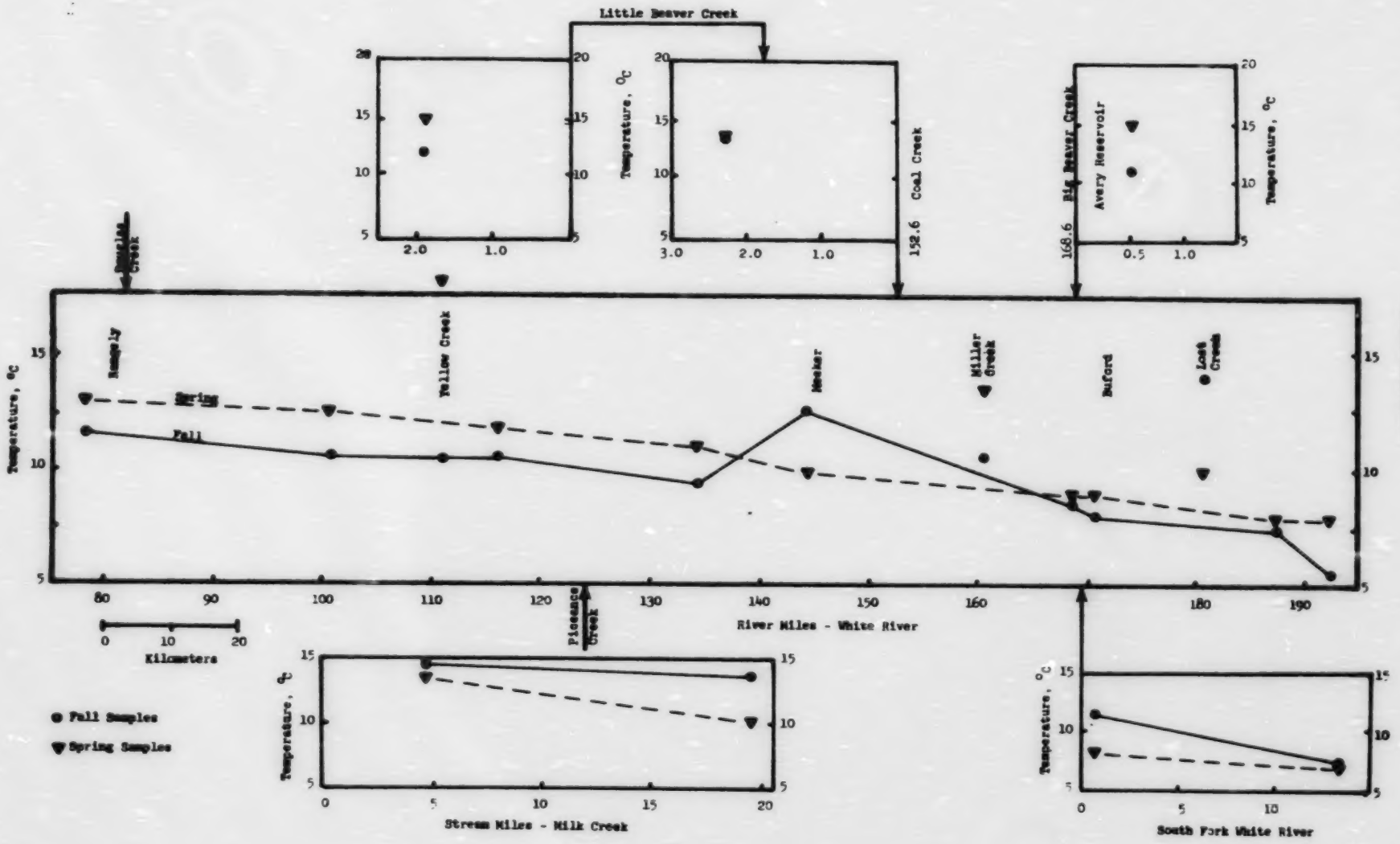


FIGURE 3
TEMPERATURE PROFILE



furthest upstream station on the White River (RM 192.6) during high flow. As shown in Fig. 4, pH values during the Fall exhibited a smooth trend of increasing pH in the downstream direction with lowest values near the headwaters (RM 187.1, pH = 7.1) and highest values downstream near Rangely (RM 78.2, pH = 8.1). During Spring runoff, this trend was much more irregular, with highest pH measurements occurring in the intermediate stream reach near Piceance Creek. The pH measurements made during "low flow" ranged from 0.2 to 1.0 SU higher than measurements made during "high flow".

Dissolved Oxygen

As shown in Fig. 5 most dissolved oxygen measurements averaged greater than 7.0 mg/l. The only exception was Yellow Creek, which averaged approximately 4 mg/l D.O. during both study periods. These concentrations were well below the minimum criteria/standard values of 5-6 mg/l. However, some difficulties were encountered in field preserving these water samples because of the foaming action caused by the reaction of the preservative reagents with the minerals in the water (TDS~4000 mg/l). The measured D.O. concentrations may, therefore, not be truly representative of the actual in-stream D.O. in Yellow Creek. Published data for D.O. concentrations at this location have been generally higher (7-9 mg/l) for these same time periods (GS, 1974).

The dissolved oxygen profiles shown in Fig. 5 for the mainstem White River indicate similar concentrations in the upstream reach during both study periods, while downstream concentrations were consistently higher during the Fall "low flow" study. These higher D.O. concentrations during "low flow" are probably related to the colder water temperatures measured during the Fall study in the lower White River drainage.

Hardness

Hardness of surface waters is composed primarily of calcium and magnesium ions. Other metal ions, such as iron, manganese, and strontium may contribute to water hardness if they are present in appreciable amounts. Although not necessarily an indicator of water quality itself, the amount of hardness present in stream water has been shown to be a significant factor in the toxicity of various metals to aquatic life.

Profiles of water hardness in the White River, in selected tributaries, and in Milk Creek are shown in Fig. 6. Hardness concentrations ranged from 35 mg/l to 265 mg/l in the mainstem White River while tributary concentrations greater than 500 mg/l were measured in Yellow Creek (566 mg/l), Little Beaver Creek (500 mg/l), and Miller Creek (514 mg/l). These measurements are indicative of very hard water and are due primarily to high concentrations of calcium and magnesium ions.

Water hardness was significantly greater during the "low flow" study due at least partially to the presence of higher concentrations of dissolved minerals (see Fig. 8 for the TDS profile). Hardness concentrations also showed a steady increase in the downstream direction in all

FIGURE 4
pH PROFILE

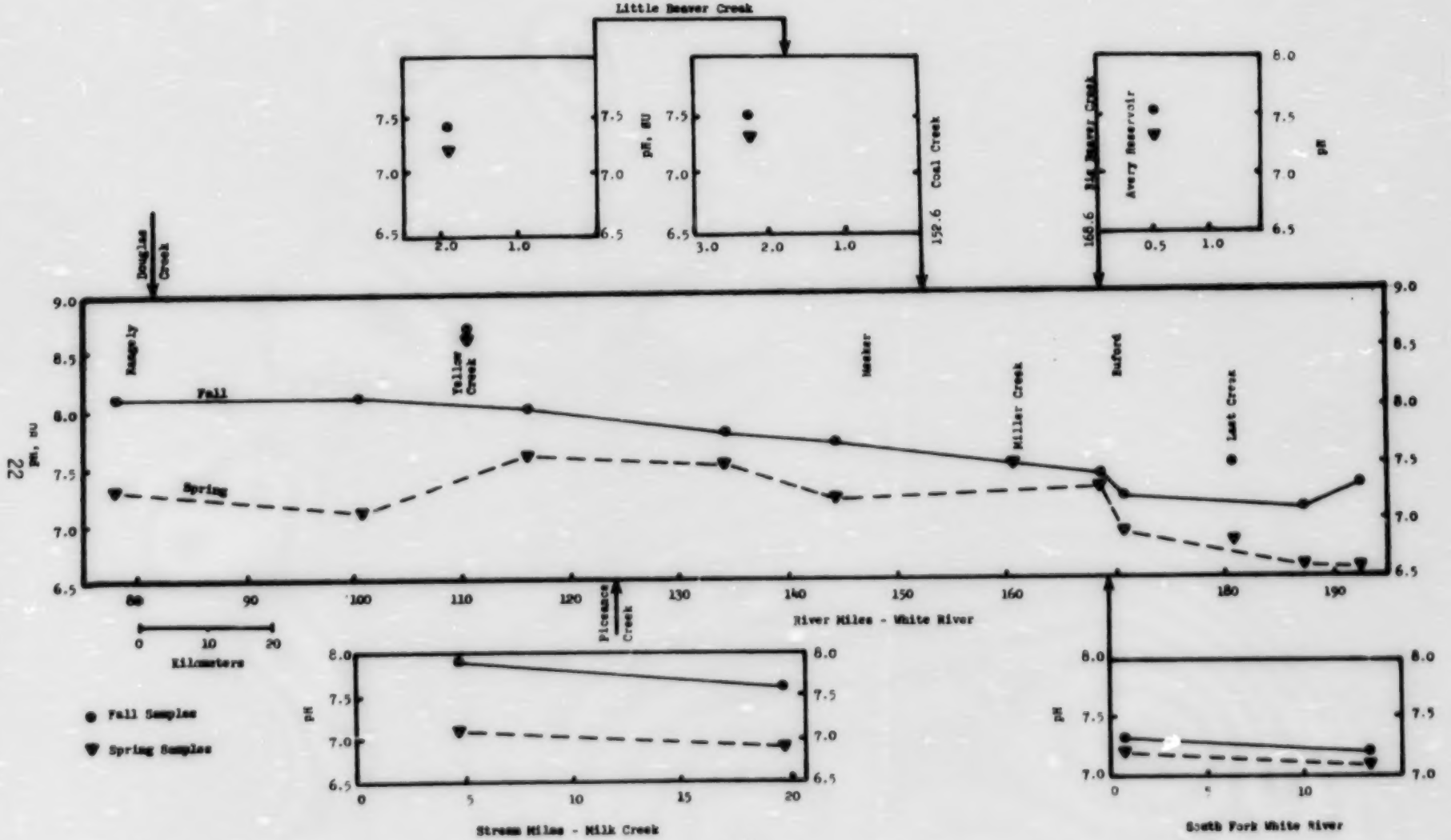


FIGURE 5
DISSOLVED OXYGEN PROFILE

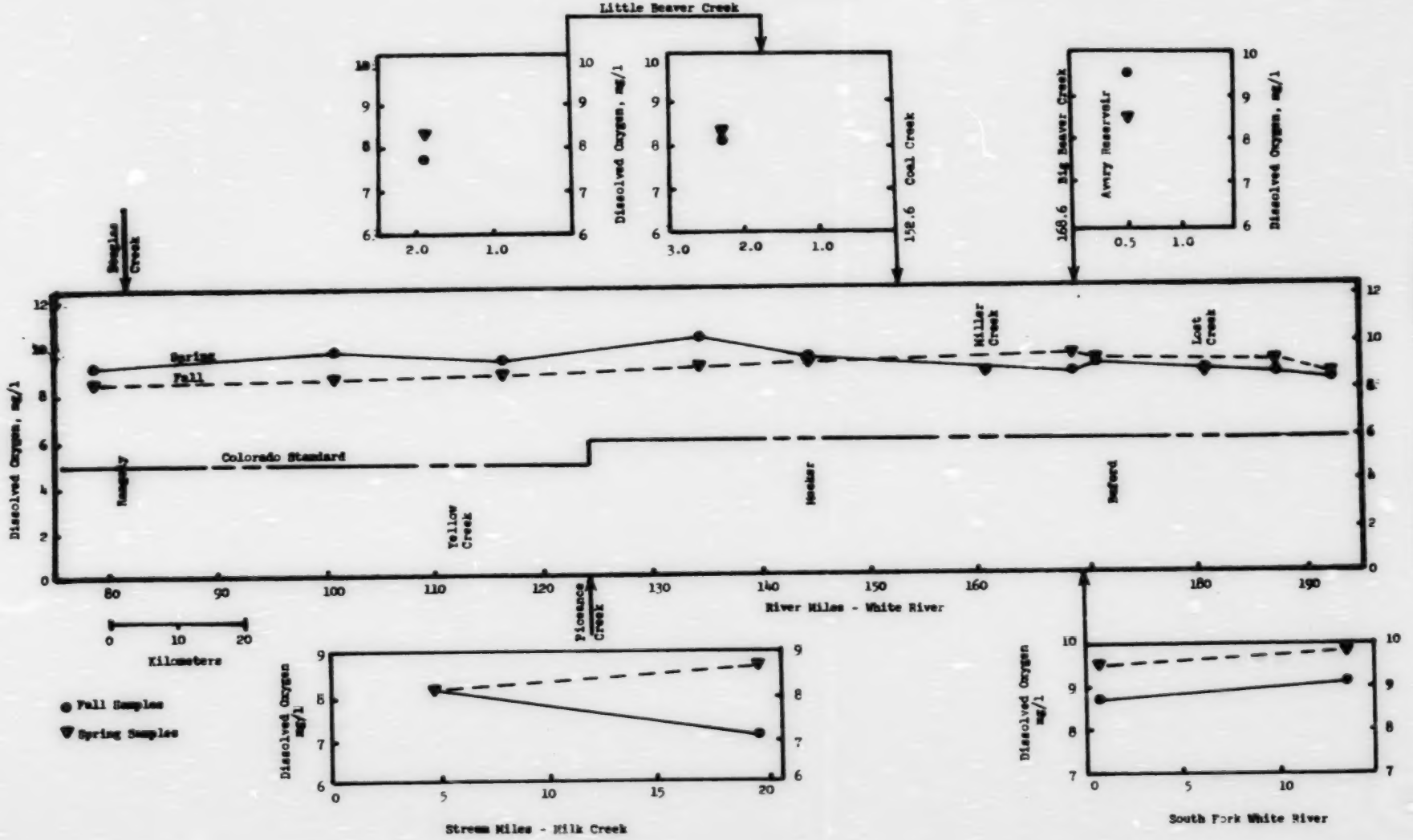
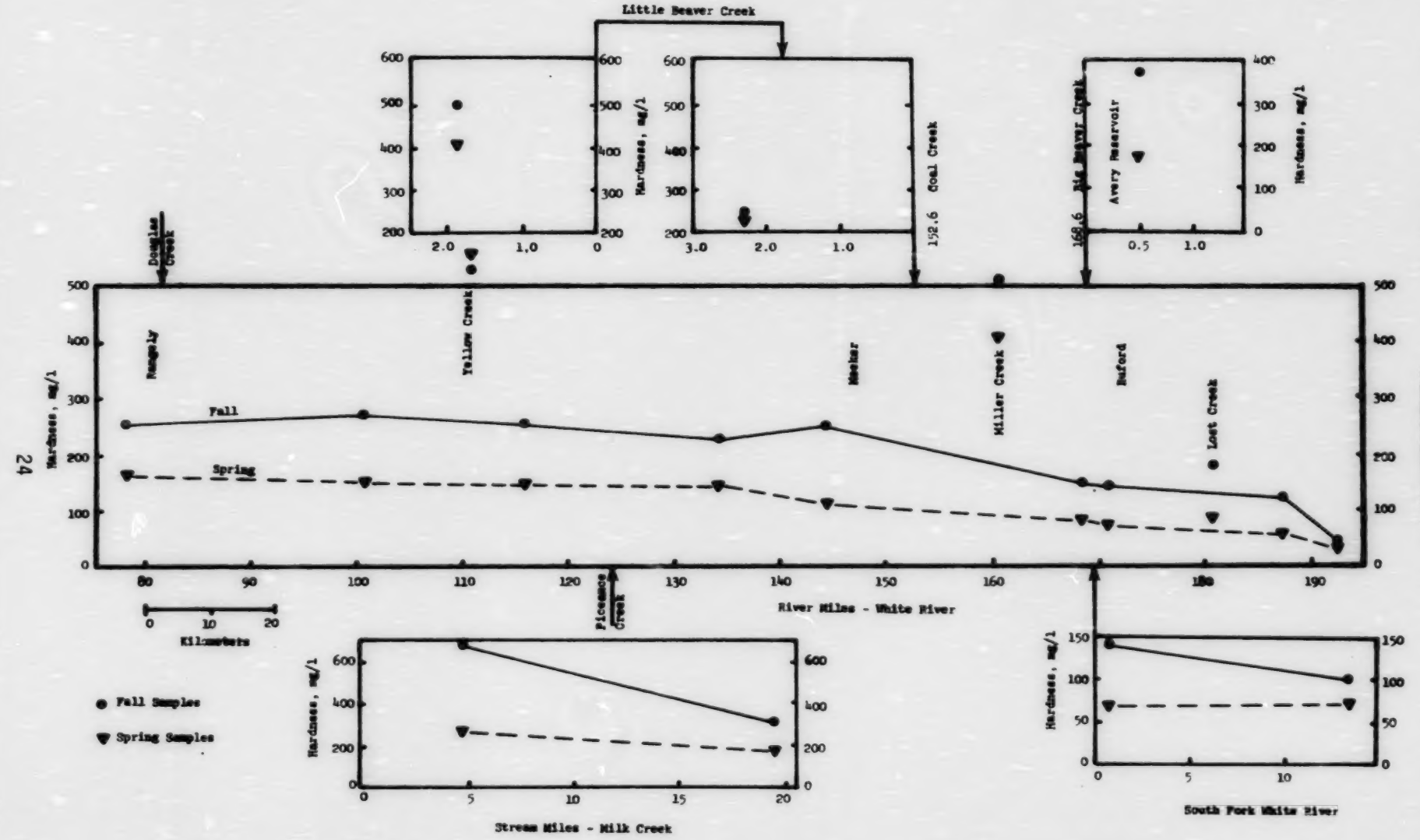


FIGURE 6
HARDNESS PROFILE



streams. During the Spring runoff study when suspended solids concentrations were relatively high, the calcium and magnesium concentrations together were not equal to the total hardness determined in the field by EDTA titration (see Table 3). The higher hardness values obtained by titration are likely due to the presence of significant concentrations of the other hardness-producing metals (especially iron) associated with the suspended solids. This explanation is especially plausible since no inhibitors were used in the EDTA titration procedure.

Alkalinity

Alkalinity is a measurement of the buffering capacity of the carbonate-bicarbonate system present in surface waters. It is important that sufficient alkalinity exist in streams to prevent wide fluctuations in pH which may be harmful to the aquatic environment. Stream measurements indicated a widespread range of total alkalinity concentrations as $CaCO_3$, ranging from 40 mg/l near the headwaters to 175 mg/l near Rangely, Colorado (see the profiles in Fig. 7). Alkalinity measurements were generally highest during the "low flow" period. The lower Milk Creek station (MC-20) exhibited an average alkalinity concentration of 331 mg/l as $CaCO_3$, while Yellow Creek (YC-3) contained an average alkalinity of more than 1500 mg/l as $CaCO_3$ during each study period.

Salinity

High salinity (TDS) concentrations may produce adverse effects in drinking water supplies and in irrigated crops. A large effort is currently underway by the Colorado River Basin Salinity Forum (1975) to mitigate these impacts by reducing salinity in the Colorado River basin, including the White River. As shown in Fig. 8 the White River in its lower reaches becomes a significant carrier of salinity, a fact shown most clearly by the salinity increases measured during "low flow". At that time (Fall, 1975) the salinity near the headwaters averaged 123 mg/l, while in the 200 km (125 mi) reach downstream to Rangely this concentration increased by more than four times to 557 mg/l. Mean TDS concentrations exceeded the criteria of 500 mg/l in the White River near Rangely (RM 78.2), and in Yellow Creek, Little Beaver Creek, Miller Creek, Big Beaver Creek, and Milk Creek. The greatest incremental increase in salinity concentrations in the White River (80%) occurred in the 38.8 km (24.1 mi) reach between Buford (WR-11) and Meeker (WR-6), which includes the tributaries Miller Creek and Coal Creek/Little Beaver Creek. This stream reach also includes the tributaries Curtis Creek and Flag Creek (which were not sampled), and the "Meeker Dome" area which has been previously documented as a significant source of highly-saline groundwater and surface runoff (EPA, 1972). Unfortunately, the scope of the present study did not allow an intensive investigation of the non-point sources of salinity in this area. The data from the Fall "low flow" study does show, however, that only approximately 50% of the increase in salinity load in the White River between stations WR-11 and WR-6 (58 metric tons per day) could be attributed to tributary loads (excluding Flag Creek, which was not sampled, and Curtis Creek, which

FIGURE 7
ALKALINITY PROFILE

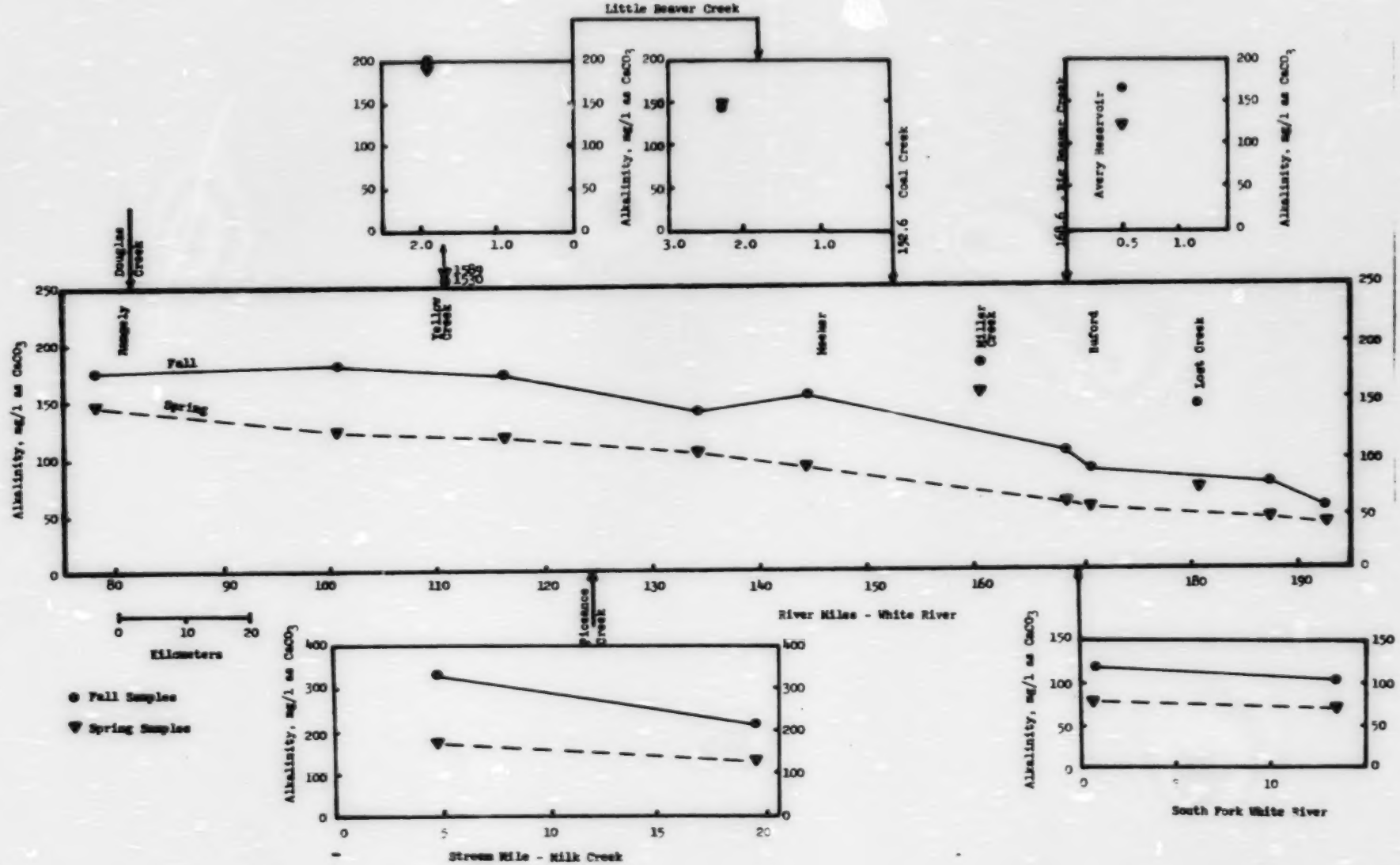
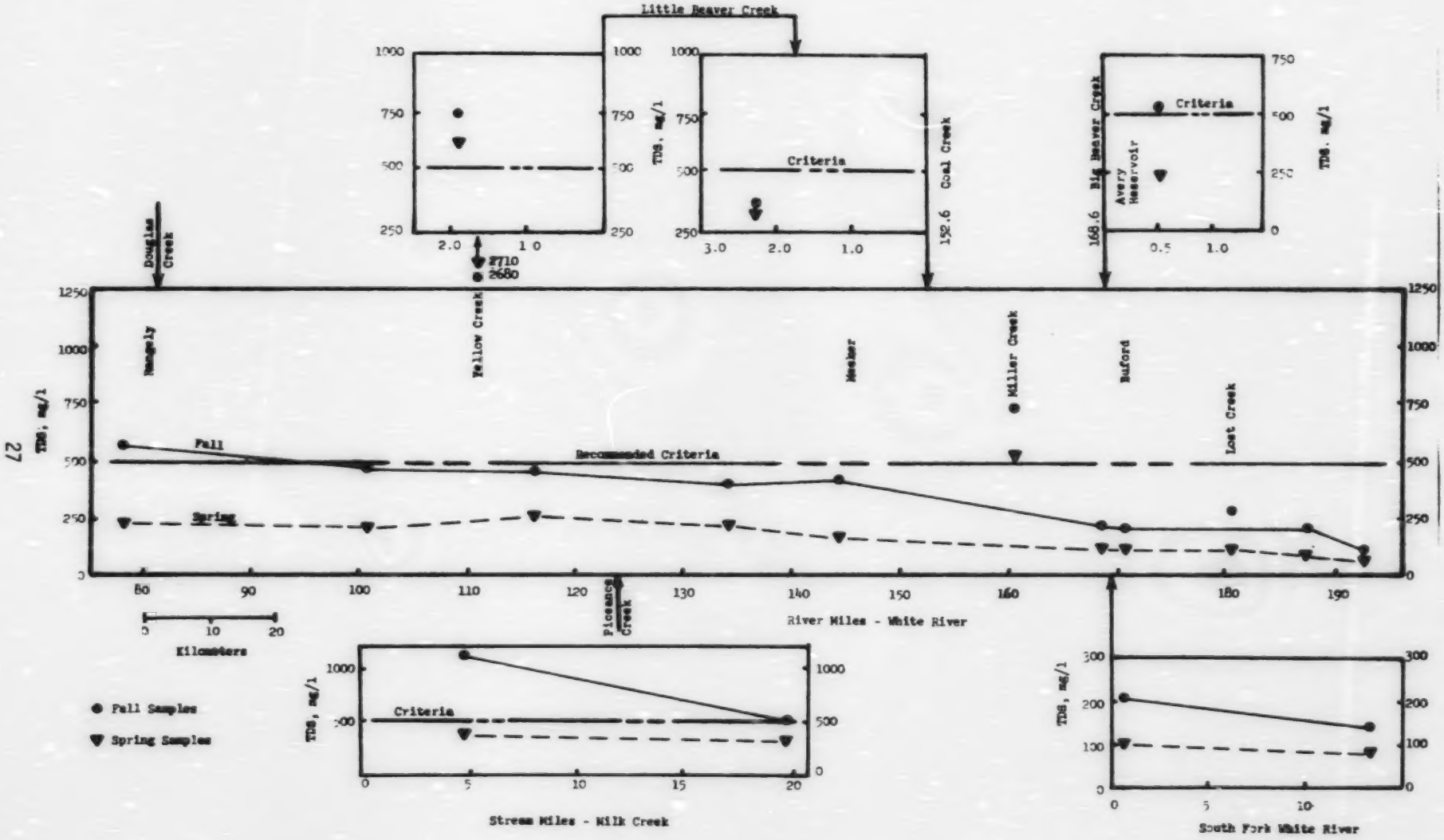


FIGURE 8
TDS PROFILE



was observed to have a negligible flow). The remaining 58 metric tons per day were due to saline groundwater inflows, irrigation return flow, and other non-point contributions (see Table 3).

Although TDS concentrations at most sampling locations were generally twice as high during the "low flow" period as during the "high flow" period, the greatest salinity load in the White River occurred at "high flow" during Spring runoff (Table 3). During this period, the salinity load increased from 32 metric tons per day near the headwaters (NF-18) to 922 metric tons per day at Rangely (WR-1). This great increase is due primarily to leaching of dissolved minerals from the exposed river banks during periods of "high flow". Sampling on Milk Creek revealed these same general trends during each flow period.

Specific conductance (conductivity) measurements were made at all locations and can be compared with TDS concentrations for each location. Except for Yellow Creek, conductivity values in the White River drainage averaged generally less than 1000 µmhos/cm, ranging from 90 µmhos/cm near Trappers Lake to 790 µmhos/cm near Rangely.

Suspended Solids

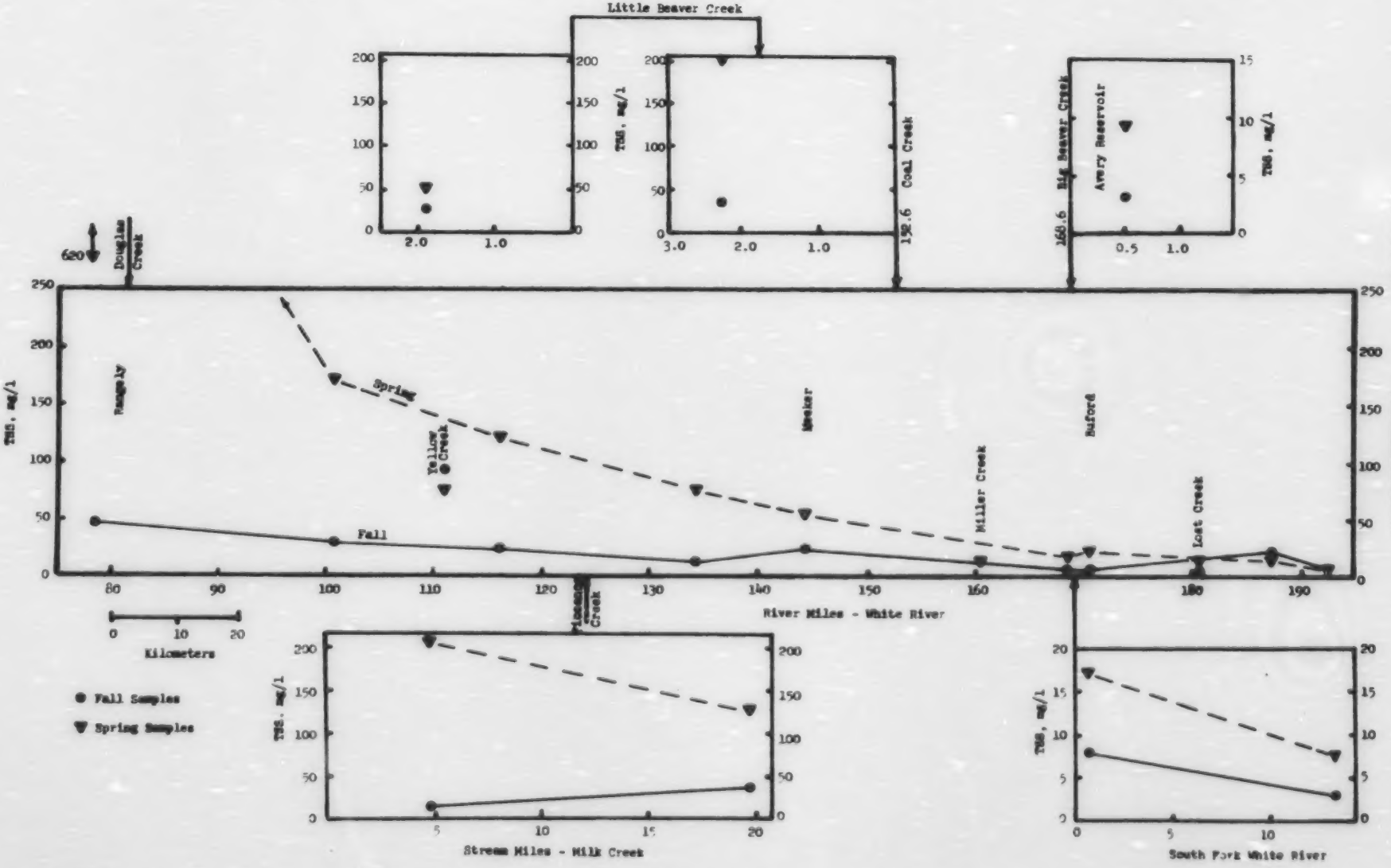
Total suspended solids (TSS) concentrations and loads were, as expected, much greater during Spring runoff than during the "low flow" study (see Table 3 and Fig. 9). Concentrations averaged generally two to ten times higher during Spring runoff (maximum concentration of 620 mg/l at WR-1), while loadings were as much as 50 times higher during runoff than during the "low flow" period (maximum load of 2432 metric tons per day at WR-1). Part of the reason for the high suspended solids concentration and load at Rangely (WR-1) during Spring runoff was that Douglas Creek was contributing approximately 1.42 m^3/s of extremely muddy water to the White River just upstream from Rangely. However, since Douglas Creek was not included in the sampling program, no chemical samples were obtained.

The recommended mean TSS criterion of 25 mg/l for fish and wildlife protection was exceeded during Spring runoff at all sampling locations on the White River below Meeker and in Yellow Creek, Little Beaver Creek, Coal Creek, and Milk Creek. During "low flow", TSS concentrations still averaged above the criterion level in all these streams and in the White River below Yellow Creek (RM 111.0). The data in Table 3 appears to show good correlation between measured turbidity values and TSS concentrations, as would be expected.

Common Minerals

Concentrations of the common minerals (calcium, magnesium, sodium, potassium, and chloride) were generally highest during the "low flow" period when groundwater recharge constituted a larger portion of the total river flow. The profiles for sodium and chloride concentrations shown in

FIGURE 9
TSS PROFILE



Figs. 10 and 11 serve as an example of the trend of increasing mineral concentration in the downstream direction which was observed for each of the common minerals. The highest mean concentrations of common minerals were generally found in Yellow Creek, Little Beaver Creek, and Coal Creek (see Table 3). Yellow Creek contained mean concentrations of sodium in excess of the recommended criteria of 270 mg/l, which was sufficient sodium to produce Sodium Adsorption Ratios (SAR) of 17 during "high flow" and 15 during "low flow". Ratios of this magnitude indicate that the water may adversely affect sodium-sensitive plants if used for irrigation (NAS, 1972).

Metals and Related Elements

A total of 13 parameters were included in this grouping, and all results are discussed in terms of the total metal. Profiles for five of these metals (aluminum, copper, iron, manganese, and zinc) are shown in Figs. 12 through 16. The remaining metals were not profiled because they either exhibited little variation throughout the stream reach or they were present in concentrations below the analytical detection limit.

The five "profiles", in combination with the metals data in Table 3, indicate significant variabilities in metal concentrations when comparing "low flow" measurements to "high flow" measurements. Mean concentrations of chromium, lead, and zinc were generally higher during "low flow", while concentrations of aluminum, cadmium, copper, and iron were generally higher during "high flow". Except for manganese, the remaining metals (arsenic, molybdenum, selenium, and silver) did not show appreciable differences in concentration between the "low flow" and "high flow" periods. Manganese concentrations averaged higher during "high flow" in the White River downstream from Meeker (see Fig. 15), but at other locations there was no apparent relationship between concentration and flow. Lithium concentrations measured during the two different flow periods could not be compared since the detection limit was reduced from 25 µg/l during the "low flow" study to 10 µg/l during the "high flow" study.

In order to evaluate the relative magnitude of the various metal concentrations, the measured values have been compared to the recommended criteria and proposed standards shown in Table 4. It should be clearly understood that the numbers shown in Table 4 are not absolute" limits, but rather are intended to serve as "alert level" indicators. There clearly is a great need for additional metal toxicity research in order to fully justify specific numerical criteria and standards such as these.

The comparison of the metals data with the recommended criteria and proposed standards (criteria/standards) leads to several observations, as follows:

1. The criteria/standard concentrations for several metals (aluminum, cadmium, lead, and silver) shown in Table 4 are below the detection limit achieved by EPA during one or both of the study periods.

FIGURE 10
SODIUM PROFILE

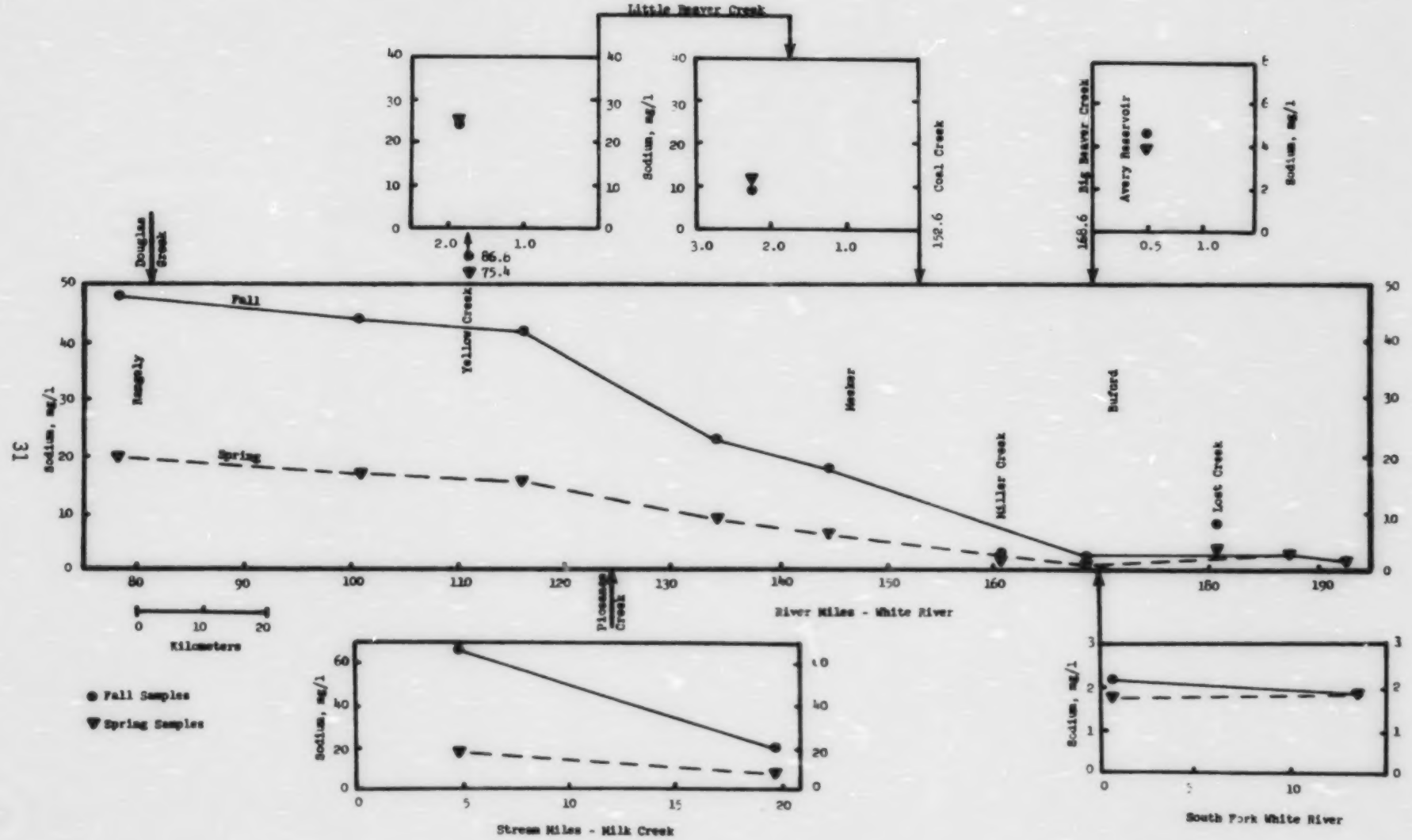


FIGURE 11
CHLORIDE PROFILE

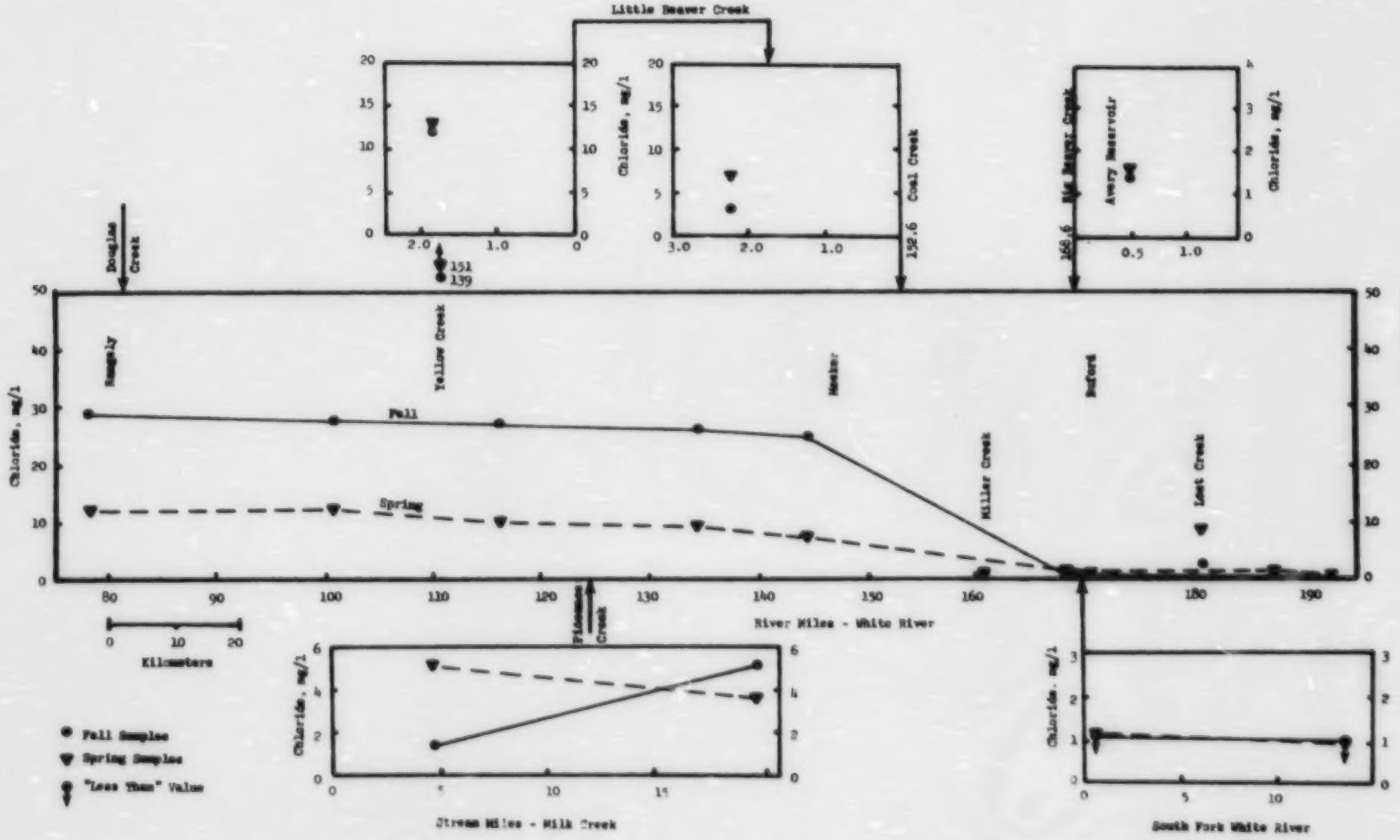


FIGURE 12
ALUMINUM PROFILE

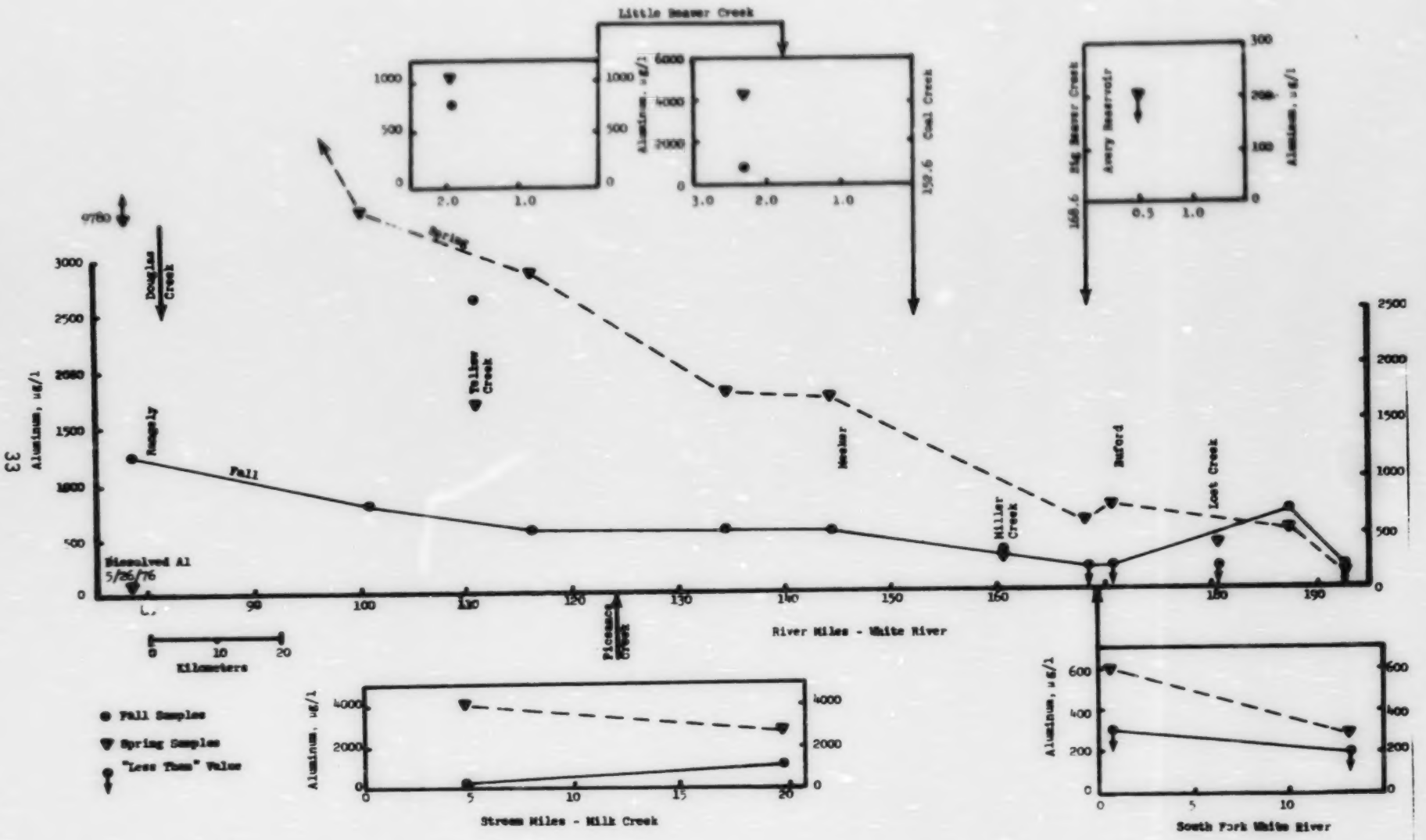


FIGURE 13
COPPER PROFILE

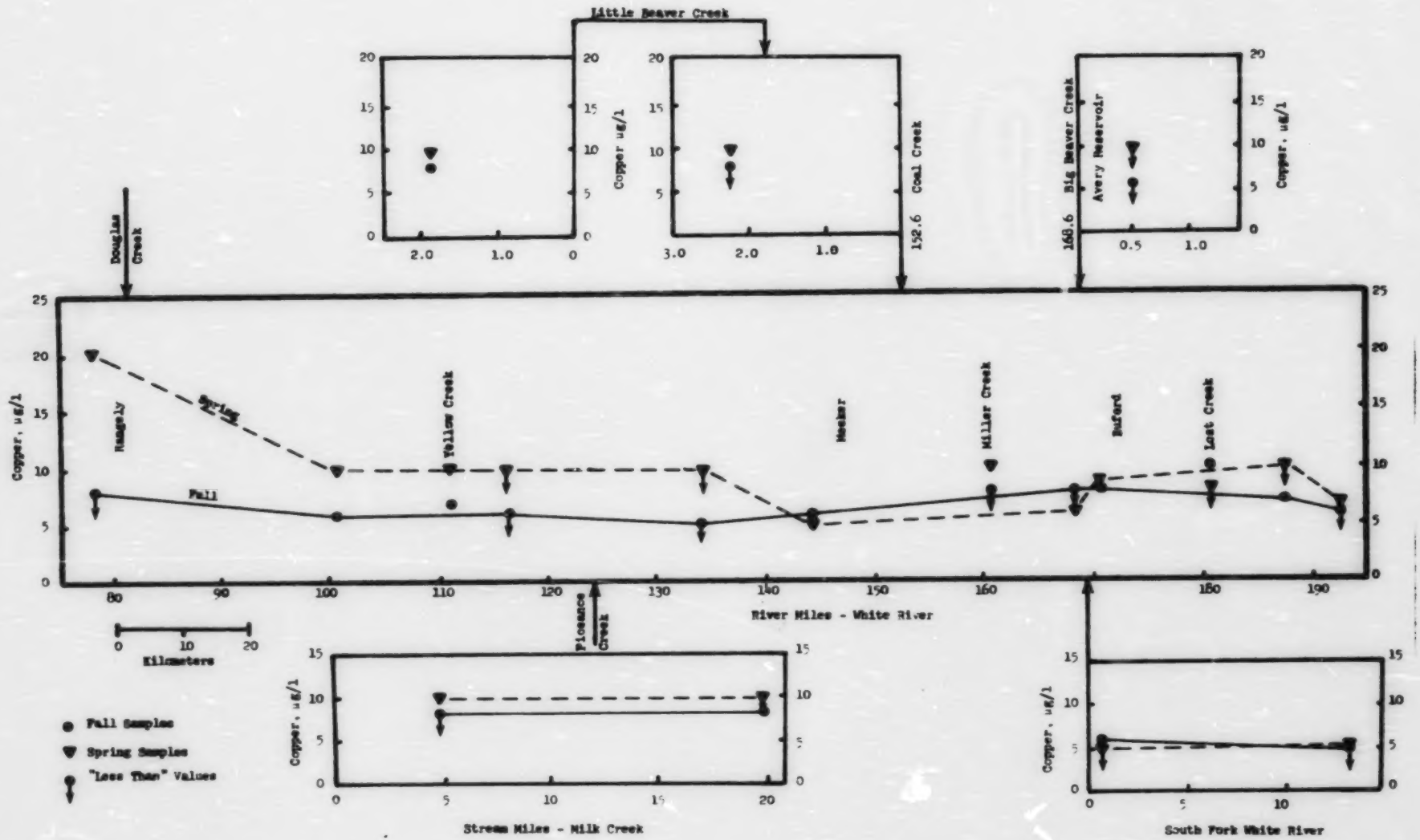


FIGURE 14
IRON PROFILE

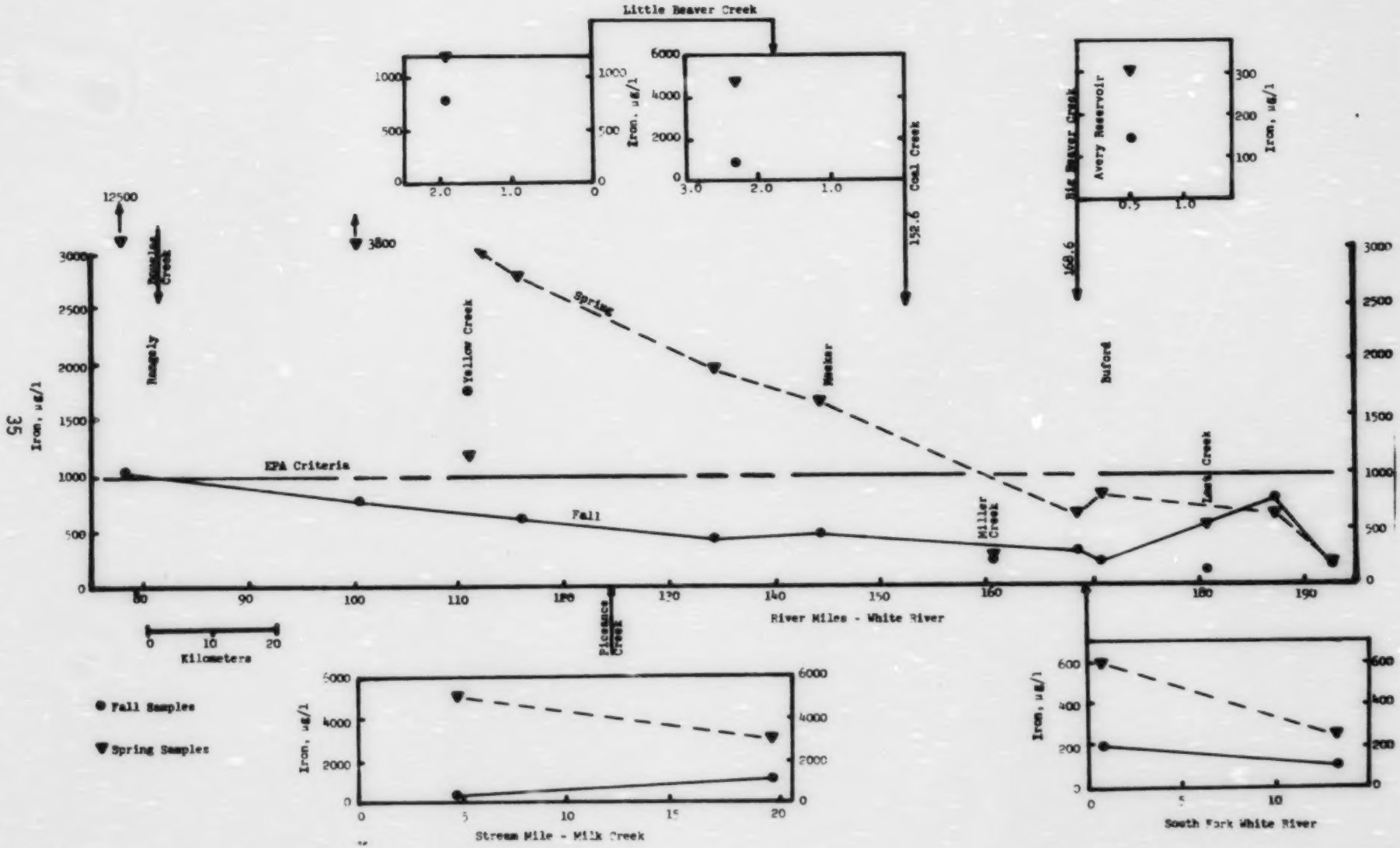


FIGURE 15
MANGANESE PROFILE

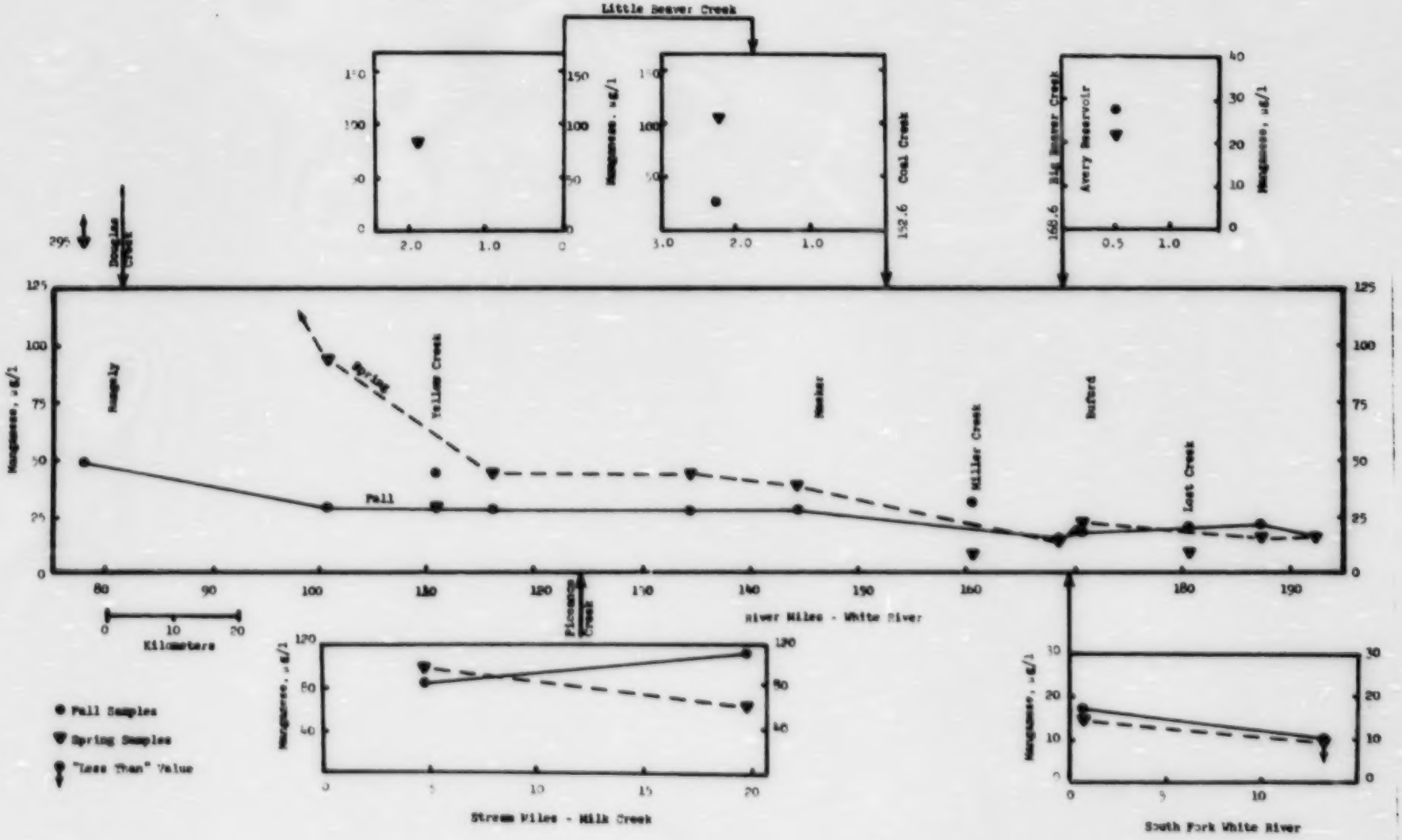
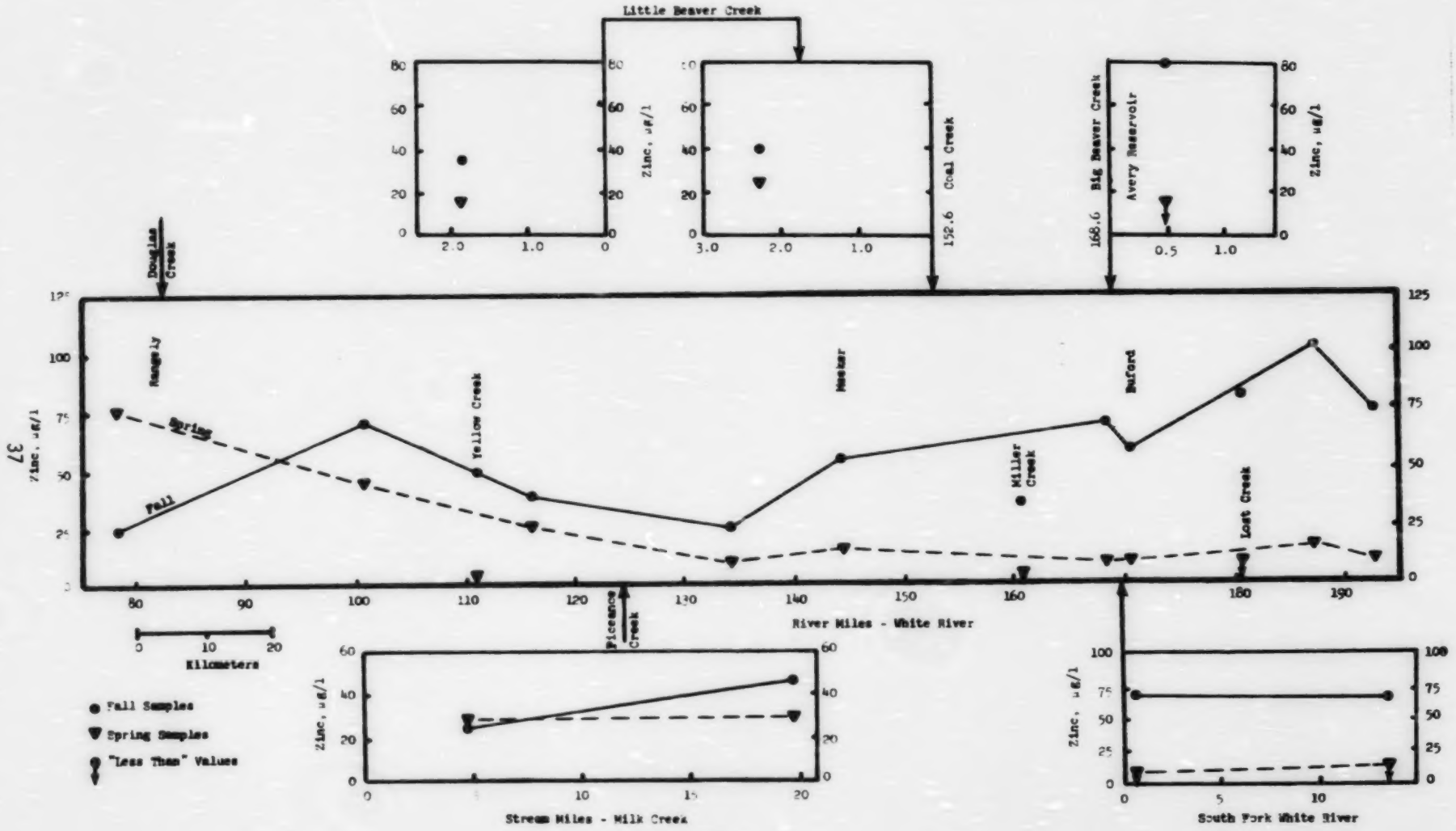


FIGURE 16
ZINC PROFILE



However, except for aluminum, these metals were found in only very trace amounts, with the maximum average concentrations reported as follows: cadmium, 12 µg/l at YC-3; lead, 10 µg/l at WR-1; and silver, 5 µg/l at WR-2 and YC-3.

2. Mean concentrations of aluminum and iron ranged as high as 9780 µg/l and 12,500 µg/l, respectively, in the lower White River drainage at Rangely. As shown in the profiles in Figs. 12 and 14, these concentrations were measured during Spring runoff when suspended sediment concentrations were also high. The recommended EPA criteria of 5000 µg/l for aluminum was exceeded at only one location (RM 78.2) whereas the proposed Colorado standard of 100 µg/l was exceeded at most locations. The proposed Colorado standard for iron (500 µg/l) was exceeded at 15 of the 19 sampling sites, as shown in Fig. 14.

3. The criteria/standard concentrations for three metals (copper, manganese, and molybdenum) were exceeded at only one station each. Yellow Creek contained mean concentrations of molybdenum which were approximately four times above the criterion of 10 µg/l, while the White River near Rangely (RM 78.2) contained concentrations of copper (20 µg/l - Fig. 13) and manganese (295 µg/l - Fig. 15) in excess of the criteria/standard limits of 10 µg/l and 200 µg/l, respectively.

4. Selenium concentrations in excess of the criteria/standard value of 10 µg/l were measured in Yellow Creek and Little Beaver Creek. The selenium concentrations in these streams averaged 16 µg/l during "low flow" at YC-3 and 25 µg/l during "high flow" at LBC-9.

5. Measurements for zinc at the 17 stations in the White River drainage indicated that 8 stations had mean concentrations in excess of the proposed standard value at the measured water hardness (the proposed zinc standards are a function of water hardness, CDH, 1976). As shown in Fig. 16, zinc concentrations were generally higher during "low flow" with the highest concentration (100 µg/l) reported near the headwaters of the White River at RM 187.1.

6. Mean concentrations of chromium were all less than 20 µg/l, which is significantly less than the criteria/standard limit of 50 µg/l.

7. The arsenic standard of 10 µg/l proposed by Colorado was equaled at the Yellow Creek station, but all other stations reported mean arsenic concentrations less than 10 µg/l.

8. Mean concentrations of total metals at the two sample stations in the Milk Creek drainage were above the criteria/standard levels for only iron and aluminum (Figs. 12 and 14). As was true for stations in the White River drainage, concentrations of these metals were highest during Spring runoff when the suspended solids load was quite high.

9. Although there are no numerical criteria shown for lithium, this metal was measured at all of the stations, generally occurring at concentrations of less than 25 µg/l. Excursions above this concentration occurred at Yellow Creek (220 µg/l), Little Beaver Creek (40 µg/l), and Milk Creek (60 µg/l).

In order to determine the effect of high suspended solids on metal concentrations, filtered and unfiltered samples were collected from the White River at Rangely (RM 78.2) on 5/26/76. This sample was extremely muddy (turbidity of 150 FTU and TSS of 600 mg/l) because of high Spring runoff flows. The dissolved and total analyses shown in Table 6 reveal the extent to which the metallic ions adhered to the suspended solids in the water. For example, aluminum, iron, magnesium, manganese, potassium, and zinc were all much more concentrated in the total form than in the dissolved form. The significant difference in the potassium concentrations may be due to a large amount of suspended illite clay which contains appreciable amounts of potassium and is a chief constituent of many shales (Jumikis, 1962; Leonards, 1962). After filtration through a 0.45µ membrane filter, metal concentrations were reduced by as much as 100 times, in the case of aluminum. Concentrations of less common trace metals, such as arsenic, cadmium, chromium, copper, lead, lithium, molybdenum, selenium, and silver were not significantly different in either the dissolved or total form. The calcium concentrations show that the dissolved form was greater than the total form, and the only possible explanation appears to be related to sample contamination.

Non-Metals

Profiles of boron and fluoride concentrations are depicted in Figs. 17 and 18, which show that both of these parameters were usually present at higher concentrations during "low flow" than during "high flow". Concentrations of boron averaged well below the criteria/standard limit of 750 µg/l, except for Yellow Creek, which averaged 1025 µg/l during the "high flow" study. Yellow Creek also contained the highest mean fluoride concentration (2.34 mg/l), which was slightly in excess of the criteria/standard limit of 2.0 mg/l. No other station contained mean fluoride concentrations greater than 0.6 mg/l.

Nutrients

The nutrient parameters included in this study were total kjehldal nitrogen, nitrite plus nitrate nitrogen, ammonia nitrogen, total phosphorus, and ortho phosphorus. These parameters were analyzed during the "high flow" study but were not included (they had not been requested) in the earlier "low flow" study. The organic fraction, as measured by TKN, comprised the majority of the nitrogen at each sample location with the highest concentrations generally being measured in the lower reach of the White River (see Fig. 19). The highly variable TKN concentrations observed at station NF-18 are thought to be due to analytical difficulties. The profile of

Table 6

Comparison of Dissolved vs. Total Parameters

Station No. WR-1 White River at Rangely, Colorado
Date: 5/26/76

Parameter	Units	Dissolved	Total
Aluminum	µg/l	<100	10050
Arsenic	µg/l	5	10
Cadmium	µg/l	<5	8
Calcium	µg/l	38500	31500
Chromium	µg/l	<10	10
Copper	µg/l	<5	15
Iron	µg/l	175	13000
Lead	µg/l	<5	10
Lithium	µg/l	15	25
Magnesium	µg/l	13000	20000
Manganese	µg/l	5	320
Molybdenum	µg/l	<10	<10
Potassium	µg/l	1600	4500
Selenium	µg/l	<5	<5
Silver	µg/l	<5	5
Sodium	µg/l	21000	21000
Zinc	µg/l	20	70

FIGURE 17
BORON PROFILE

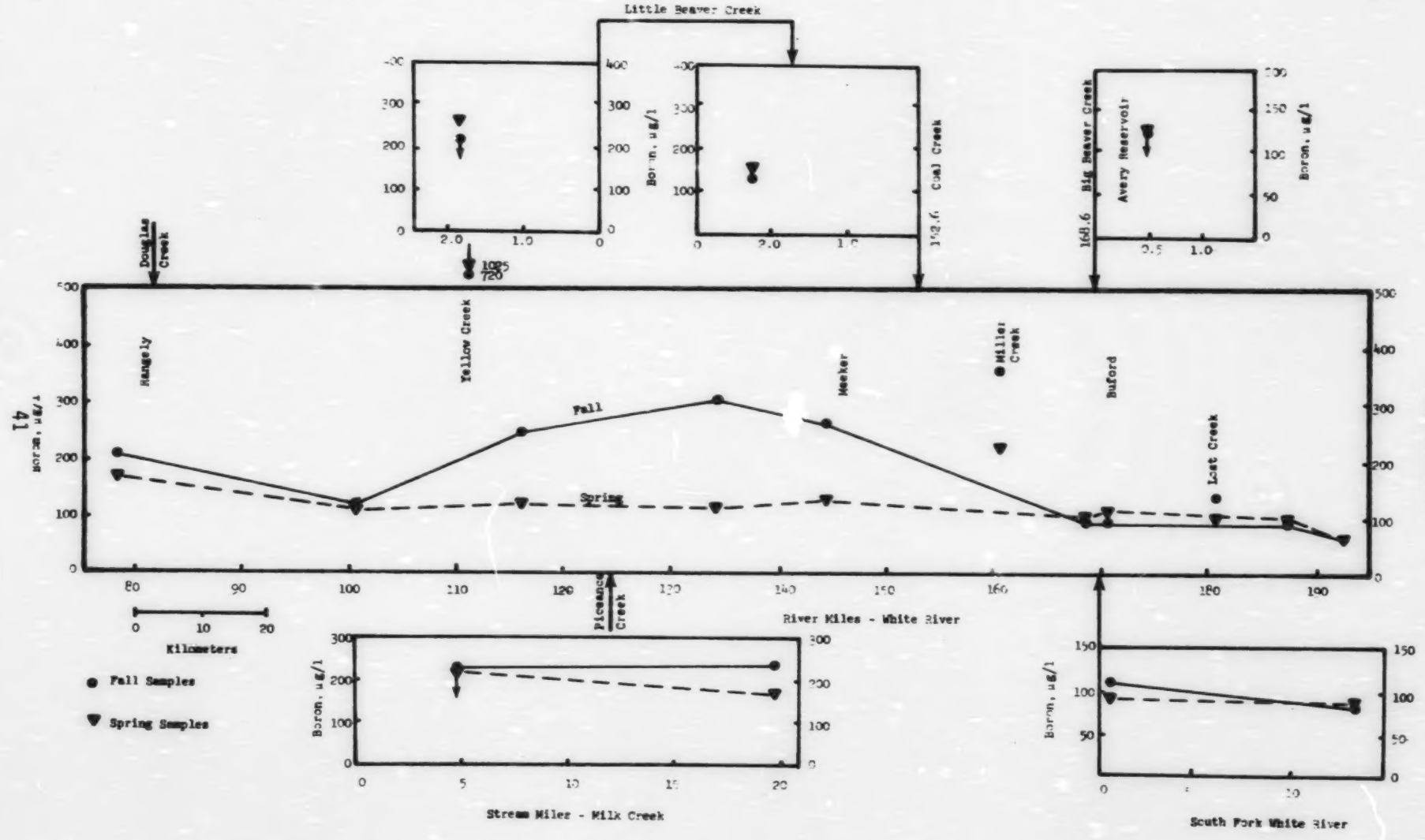


FIGURE 18
FLUORIDE PROFILE

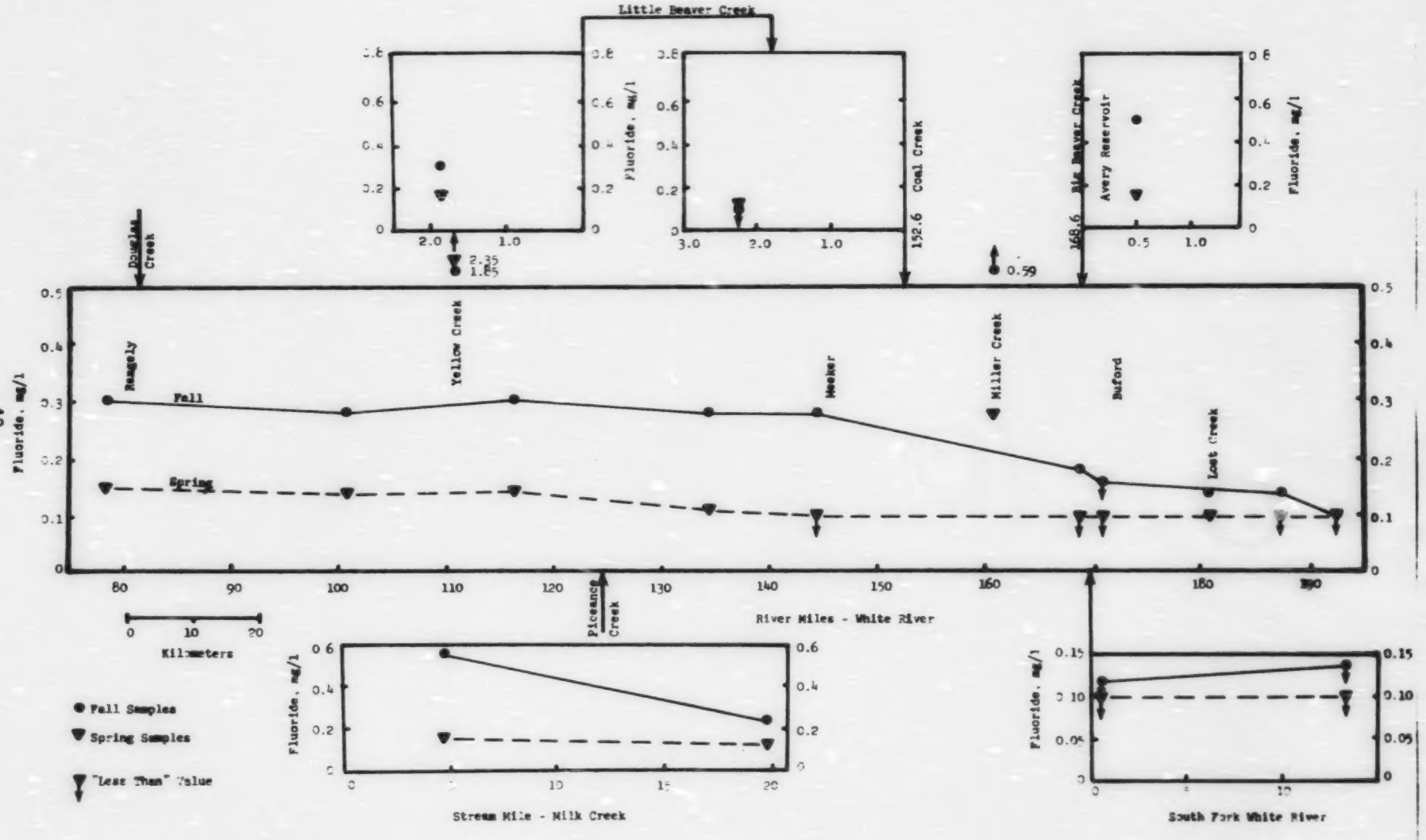
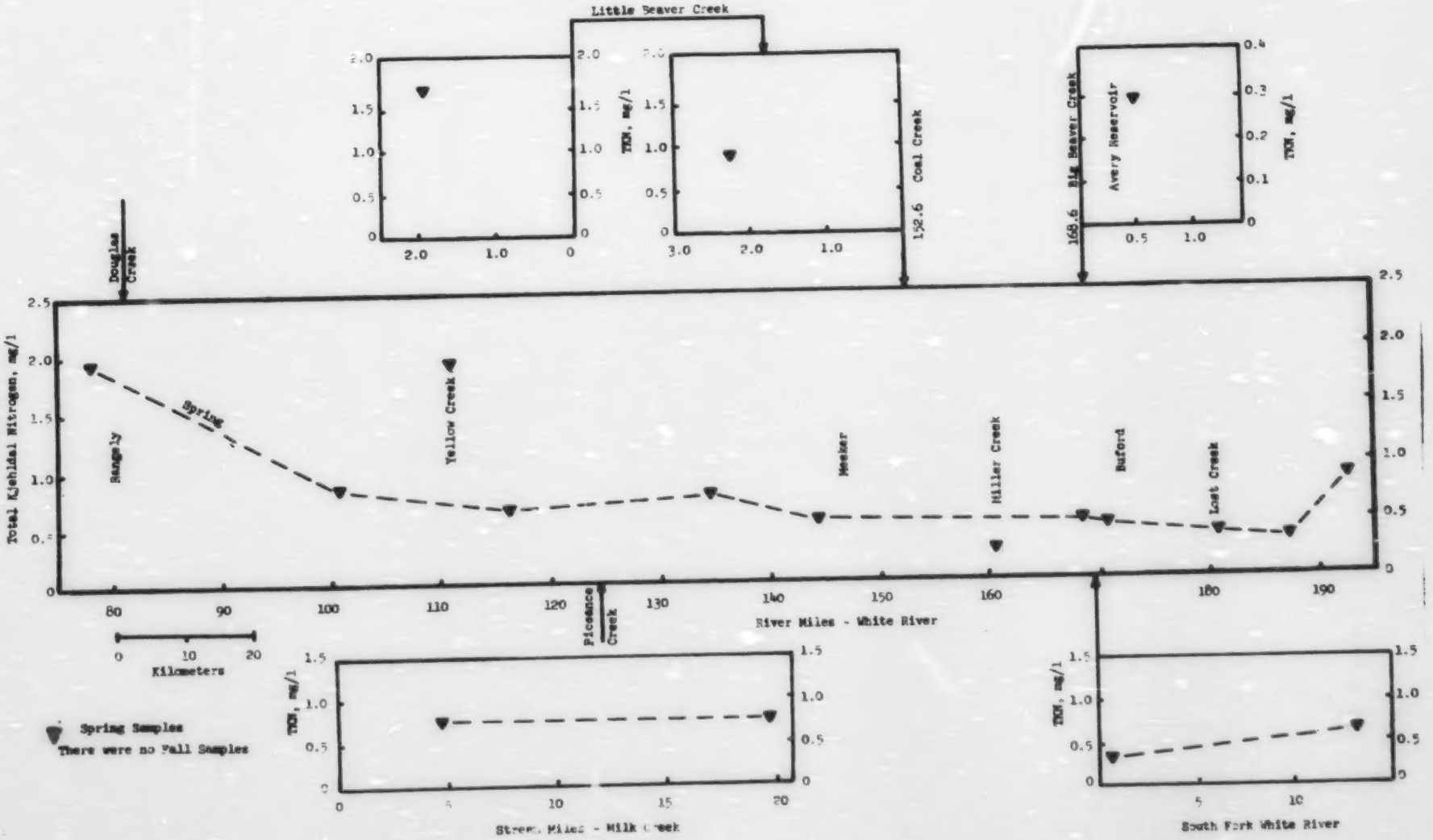


FIGURE 19
TOTAL KJEHLDAL NITROGEN PROFILE



nitrite + nitrate concentrations in Fig. 20 shows a general increase in concentrations in the downstream direction similar to the TKN profile. Phosphorus levels generally tended to follow the same pattern of increasing concentrations in the downstream direction, as shown in Fig. 21. Mean total phosphorus concentrations in excess of the criteria/standard limit of 0.1 mg/l were measured in Little Beaver Creek (0.419 mg/l), Coal Creek, (0.250 mg/l), Milk Creek (0.183 mg/l) and at all White River sampling stations downstream from Meeker (maximum of 0.630 mg/l at RM 78.2). These measurements indicate the presence of nutrients in sufficient concentrations to warrent concern over excessive algal growth should the waters in the lower White River basin be impounded. Of course, further study in the form of algal assays and additional stream sampling would be required in order to fully evaluate this possiblity. Irrigation return flows were the likely cause of elevated levels of phosphorus in the three creeks, but, as shown in Table 3, the phosphorus load from these tributaries (a total of <0.01 kg/day) did not contribute significantly to the total phosphorus load in the White River.

FIGURE 20
NITRITE + NITRATE NITROGEN PROFILE

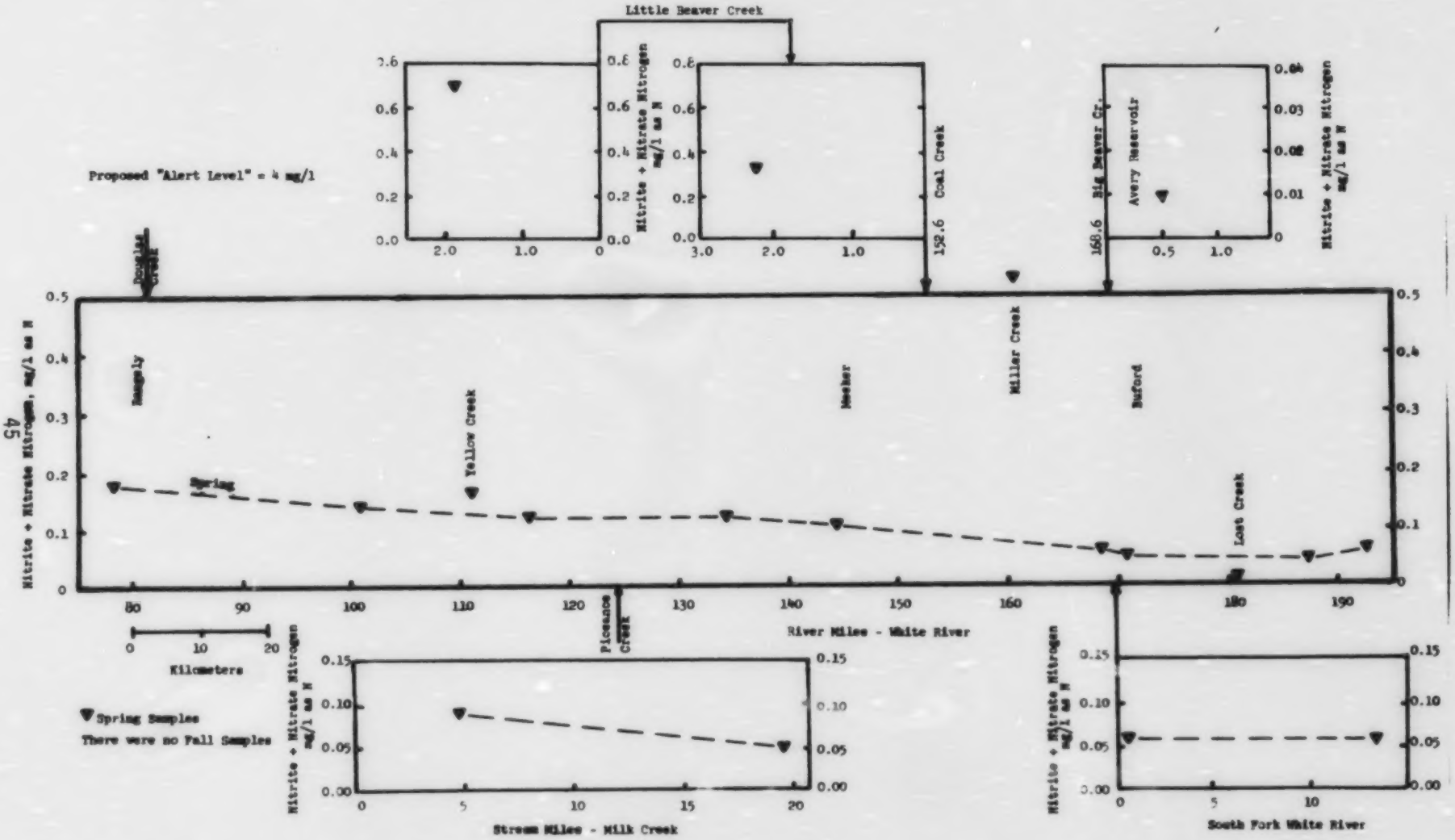
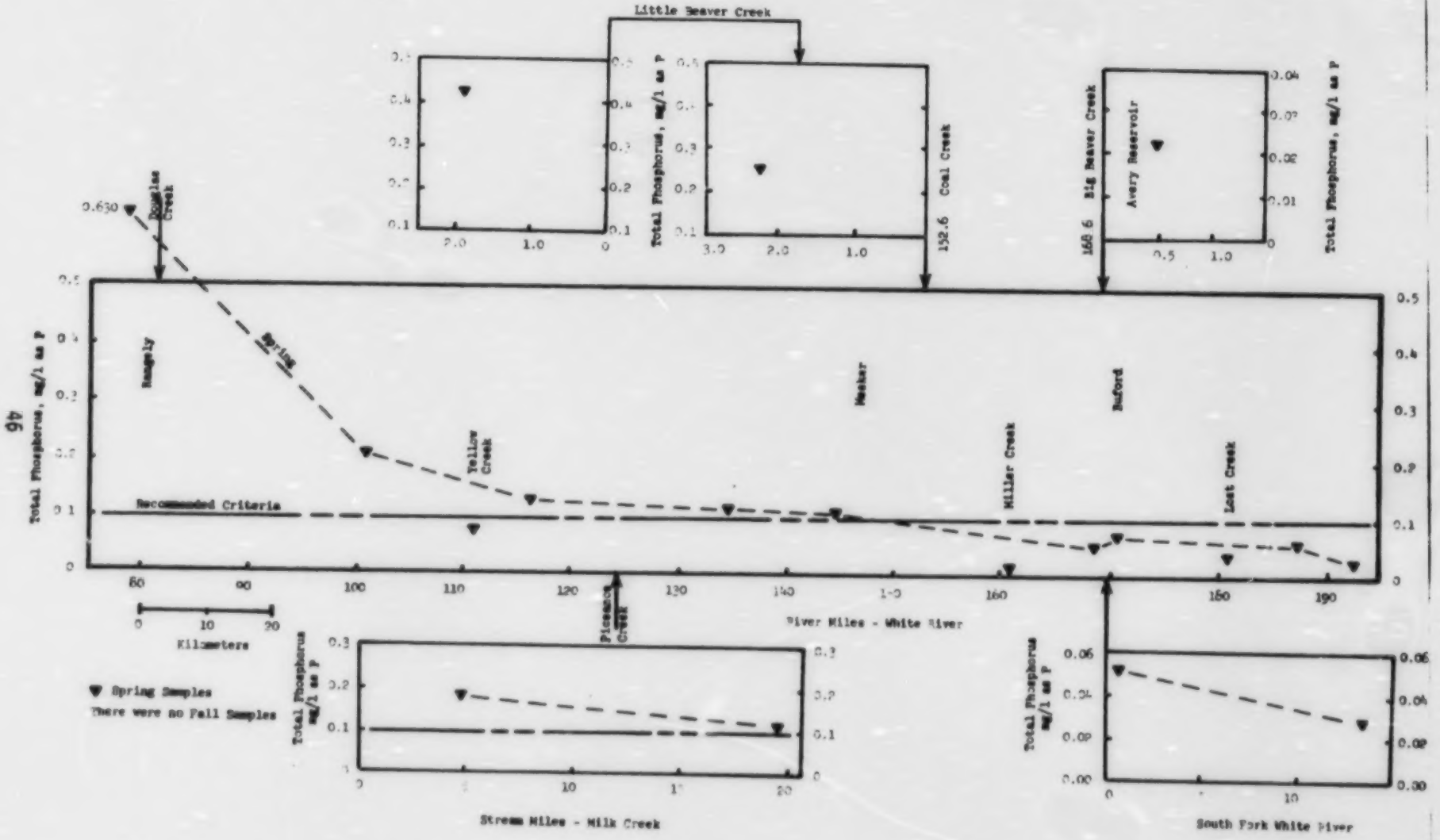


FIGURE 21
TOTAL PHOSPHORUS PROFILE



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APPENDIX A

DATA FROM THE FALL, 1975

"LOW FLOW" STUDY

WHITE RIVER STUDY

Station No. WR-1

Parameter	Units	9/29/75	9/30/75	10/1/75	10/2/75
Time	Mtly	1430	0950	0955	1030
Temperature	Cent	14.5	11.0	10.0	10.0
pH	SU	8.5	7.8	8.3	8.2
Flow* (USGS)	cfs	(468)	(468)	(474)	(468)
DO	mg/l	9.4	9.0	9.3	9.3
Conductivity	µmhos/cm	790	760	710	760
Turbidity	FTU	18	20	16	15
Alkalinity (as $CaCO_3$)	mg/l	180	160	180	180
Hardness	mg/l	256	250	260	252
TDS	mg/l	454	484	460	830
TSS (Grab)	mg/l	55	53	40	32
TSS (Comp.)***	mg/l	-	48	-	22
Tot. Chloride	mg/l	29	29	29	29
Tot. Fluoride	mg/l	0.26	0.36	0.32	0.27
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	1000	1400	1300	1300
Tot. Boron	µg/l	330	140	190	190
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	55,000	58,000	53,000	65,000
Tot. Chromium	µg/l	15	15	<10	10
Tot. Copper	µg/l	10	12	<5	6
Tot. Iron	µg/l	850	1150	1000	1100
Tot. Lead	µg/l	<5	<5	<5	<5
Tot. Lithium	µg/l	<25	155**	<25	<25
Tot. Magnesium	µg/l	24,000	23,000	23,000	23,000
Tot. Manganese	µg/l	40	1260**	74	32
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	2200	2800	2200	2200
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	56,000	46,000	46,000	44,000
Tot. Zinc	µg/l	15	15	25	40

* Flow data from USGS, measured at gaging station located 4.7mi. upstream from Rangely, Colorado No flow in Douglas Creek.

** These values are considered spurious and unrepresentative due to an unknown cause.

*** All TSS (comp.) results are depth-integrated total suspended solids, not time-composited solids.

WHITE RIVER STUDY

Station NO. WR-2

Parameter	Units	9/29/75	9/30/75	10/1/75	10/2/75
Time	Mtly	1350	1035	1105	1000
Temperature	Cent	13.5	11.0	9.5	8.0
pH	SU	8.3	8.3	7.8	8.3
Flow* (USGS)	cfs	(468)	(468)	(474)	(468)
DO	mg/l	10.1	9.3	9.9	9.8
Conductivity	µmhos/cm	820	790	720	820
Turbidity	FTU	10	7.1	12	8.5
Alkalinity (as $CaCO_3$)	mg/l	192	180	180	180
Hardness	mg/l	260	288	260	252
TDS	mg/l	488	472	454	456
TSS (Grab)	mg/l	31	40	28	22
TSS (Comp.)	mg/l	33	-	38	-
Tot. Chloride	mg/l	28	27	28	29
Tot. Fluoride	mg/l	0.24	0.24	0.33	0.33
Tot. Arsenic	µg/l	5	<5	5	<5
Tot. Aluminum	µg/l	700	950	850	750
Tot. Boron	µg/l	100	110	180	110
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	58,000	60,000	53,000	61,000
Tot. Chromium	µg/l	10	<10	<10	10
Tot. Copper	µg/l	8	6	6	6
Tot. Iron	µg/l	720	910	710	690
Tot. Lead	µg/l	<5	<5	<5	<5
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	23,000	23,000	22,000	22,000
Tot. Manganese	µg/l	26	30	30	26
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	2200	2100	2000	2000
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	47,000	45,000	45,000	41,000
Tot. Zinc	µg/l	20	15	175	60

* Flow was not measured due to the proximity of this station with the USGS gaging station located 4.7mi. upstream from Rangely. Flows shown are those measured at the USGS station, and are assumed to be fairly representative of the flow at this station (WR-2).

WHITE RIVER STUDY

Station No. YC-3

Parameter	Units	9/29/75	9/30/75	10/1/75	10/2/75
Time	Mtly	1330	1100	1130	0935
Temperature	Cent	19.0	12.5	7.0	3.5
pH	SU	8.8	8.8	8.7	8.7
Flow (USGS)	cfs	(1.2)	(1.2)	0.8*(1.2)	(1.1)
DO	mg/l	Invalid	Invalid	5.4	2.2
Conductivity	µmhos/cm	3815	3815	3815	3815
Turbidity	FTU	48	25	72	15
Alkalinity (as $CaCO_3$)	mg/l	1580	1400	1620	1520
Hardness	mg/l	516	528	532	544
TDS	mg/l	2590	2590	2940	2620
TSS (Grab)	mg/l	119	62	147	37
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	138	138	141	140
Tot. Fluoride	mg/l	2.22	1.64	1.92	1.62
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	3400	1100	4600	1150
Tot. Boron	µg/l	760	760	700	680
Tot. Cadmium	µg/l	5	5	5	<5
Tot. Calcium	µg/l	18,000	20,000	22,000	22,000
Tot. Chromium	µg/l	10	10	<10	<10
Tot. Copper	µg/l	8	8	6	6
Tot. Iron	µg/l	2050	1050	3150	700
Tot. Lead	µg/l	<5	<5	<5	<5
Tot. Lithium	µg/l	125	130	125	140
Tot. Magnesium	µg/l	110,000	105,000	105,000	110,000
Tot. Manganese	µg/l	50	32	68	30
Tot. Molybdenum	µg/l	45	40	45	45
Tot. Potassium	µg/l	5900	5400	6400	5400
Tot. Selenium	µg/l	12	15	20	15
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	900,000	850,000	870,000	850,000
Tot. Zinc	µg/l	25	10	110	60

* EPA flow measurement.

WHITE RIVER STUDY

Station No. WR-4

Parameter	Units	9/29/75	9/30/75	10/1/75	10/2/75
Time	Mtly	1515	1125	1155	0915
Temperature	Cent	14.0	10.5	9.5	7.5
pH	SU	8.1	7.8	7.9	8.1
Flow* (USGS)	cfs	(488)	(496)	(491)	(482)
DO	mg/l	10.1	9.9	8.5	9.6
Conductivity	µmhos/cm	720	740	740	730
Turbidity	FTU	9	9.5	6.8	6.3
Alkalinity (as $CaCO_3$)	mg/l	180	160	180	180
Hardness	mg/l	244	256	256	256
TDS	mg/l	448	452	462	468
TSS (Grab)	mg/l	23	27	22	19
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	27	27	27	28
Tot. Fluoride	mg/l	0.32	0.24	0.33	0.33
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	650	<200	650	750
Tot. Boron	µg/l	220	320	130	320
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	58,000	55,000	60,000	63,000
Tot. Chromium	µg/l	<10	15	<10	10
Tot. Copper	µg/l	<5	6	<5	<5
Tot. Iron	µg/l	590	760	560	580
Tot. Lead	µg/l	<5	<5	<5	<5
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	23,000	23,000	23,000	22,000
Tot. Manganese	µg/l	28	30	30	26
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	2000	2000	2000	2000
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	41,000	44,000	42,000	41,000
Tot. Zinc	µg/l	10	10	95	45

* Flow assumed similar to flow at WR-5 plus flow from Piceance Cr.

WHITE RIVER STUDY

Station No. WR-5

Parameter	Units	9/29/75	9/30/75	10/1/75	10/2/75
Time	Mtly	1245	1155	1220	0855
Temperature	Cent	11.0	10.5	9.0	6.5
pH	SU	7.6	7.7	8.1	8.2
Flow* (USGS)	cfs	(460)	(466)	(460)	(448)
DO	mg/l	10.6	10.0	10.9	9.8
Conductivity	µmhos/cm	630	630	640	610
Turbidity	FTU	5.5	5.3	5.0	4.8
Alkalinity (as $CaCO_3$)	mg/l	148	140	140	140
Hardness	mg/l	236	240	232	232
TDS	mg/l	400	410	408	392
TSS (Grab)	mg/l	14	14	12	14
TSS (Comp.)	mg/l	-	15	-	14
Tot. Chloride	mg/l	26	26	27	26
Tot. Fluoride	mg/l	0.26	0.28	0.33	0.25
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	650	450	500	600
Tot. Boron	µg/l	300	350	240	320
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	60,000	58,000	60,000	61,000
Tot. Chromium	µg/l	<10	<10	<10	<10
Tot. Copper	µg/l	<5	<5	<5	<5
Tot. Iron	µg/l	410	380	360	540
Tot. Lead	µg/l	<5	<5	<5	<5
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	18,000	18,000	17,000	16,000
Tot. Manganese	µg/l	28	24	26	32
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1700	1800	1800	3000
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	26,000	23,000	22,000	22,000
Tot. Zinc	µg/l	10	5	60	25

* Flow data from USGS.

WHITE RIVER STUDY

Station No. WR-6

Parameter	Units	9/15/75	9/16/75	9/17/75	9/18/75
Time	Mtly	1420	1025	1005	0925
Temperature	Cent	13.0	12.0	12.5	12.5
pH	SU	8.0	8.0	7.8	7.4
Flow* (USGS)	cfs	(329)	(319)	(316)	(304)
DO	mg/l	10.4	9.7	9.5	8.7
Conductivity	µmhos/cm	650	650	630	600
Turbidity	FTU	5.0	6.7	7.0	7.0
Alkalinity (as $CaCO_3$)	mg/l	154	156	156	150
Hardness	mg/l	260	256	256	244
TDS	mg/l	430	422	406	432
TSS (Grab)	mg/l	23	16	24	25
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	24	25	25	25
Tot. Fluoride	mg/l	0.26	0.24	0.31	0.31
Tot. Arsenic	µg/l	<5	5	<5	<5
Tot. Aluminum	µg/l	350	450	500	850
Tot. Boron	µg/l	390	140	<100	<100
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	60,000	61,000	60,000	61,000
Tot. Chromium	µg/l	10	<10	10	10
Tot. Copper	µg/l	6	<5	<5	6
Tot. Iron	µg/l	355	440	510	650
Tot. Lead	µg/l	<5	<5	5	<5
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	19,000	20,000	19,000	19,000
Tot. Manganese	µg/l	25	26	32	30
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1900	1800	1700	1800
Tot. Selenium	µg/l	5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	17,000	17,000	19,000	20,000
Tot. Zinc	µg/l	15	35	100	65

* Flow assumed to be similar to USGS flow measurements at station located 2.5mi. upstream from Meeker.

WHITE RIVER STUDY

Station No. CC-8

Parameter	Units	9/15/75	9/16/75	9/17/75	9/18/75
Time	Mtly	1510	1055	0910	0855
Temperature	Cent	13.0	13.0	13.0	13.0
pH	SU	8.0	7.7	7.4	7.3
Flow *(EPA)	cfs	-	-	15.9	-
DO	mg/l	8.4	7.9	8.1	7.9
Conductivity	µ mhos/cm	590	570	560	530
Turbidity	FTU	9.6	11	13	17
Alkalinity (as $CaCO_3$)	mg/l	142	148	144	140
Hardness	mg/l	248	252	248	232
TDS	mg/l	392	392	402	350
TSS (Grab)	mg/l	26	25	34	53
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	3.4	3.4	3.7	2.9
Tot. Fluoride	mg/l	0.11	<0.1	<0.1	<0.1
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	550	650	1000	1300
Tot. Boron	µg/l	130	100	190	100
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	58,000	61,000	63,000	53,000
Tot. Chromium	µg/l	<10	15	10	10
Tot. Copper	µg/l	<5	<5	<5	18
Tot. Iron	µg/l	700	740	890	1050
Tot. Lead	µg/l	5	<5	<5	<5
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	19,000	20,000	21,000	19,000
Tot. Manganese	µg/l	30	34	18	24
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1800	1800	1800	1700
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	9500	9700	10,100	8400
Tot. Zinc	µg/l	60	35	45	25

* Flows did not vary significantly from day to day.

WHITE RIVER STUDY

Station No. LBC-9

Parameter	Units	9/15/75	9/16/75	9/17/75	9/18/75
Time	Mtly	1500	1045	0925	0845
Temperature	Cent	14.5	11.5	11.5	10.5
pH	SU	7.5	7.7	7.3	7.3
Flow* (EPA)	cfs	-	-	3.2	-
DO	mg/l	8.0	8.4	7.5	6.8
Conductivity	µmhos/cm	1040	1040	1040	930
Turbidity	FTU	11	10	12	16
Alkalinity (as $CaCO_3$)	mg/l	204	204	214	194
Hardness	mg/l	476	520	532	472
TDS	mg/l	734	766	788	722
TSS (Grab)	mg/l	24	22	25	32
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	13	12	13	11
Tot. Fluoride	mg/l	0.34	0.26	0.32	0.29
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	650	650	750	1000
Tot. Boron	µg/l	280	210	300	<100
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	89,000	88,000	90,000	82,000
Tot. Chromium	µg/l	10	15	15	15
Tot. Copper	µg/l	6	14	6	6
Tot. Iron	µg/l	810	630	730	950
Tot. Lead	µg/l	<5	<5	<5	15
Tot. Lithium	µg/l	30	30	30	25
Tot. Magnesium	µg/l	46,000	46,000	48,000	46,000
Tot. Manganese	µg/l	75	80	92	90
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	3700	2800	2800	2300
Tot. Selenium	µg/l	10	10	20	10
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	24,000	25,000	26,000	20,000
Tot. Zinc	µg/l	30	35	45	25

* Flows did not vary significantly from day to day.

WHITE RIVER STUDY

Station No. MC-10

Parameter	Units	9/15/75	9/16/75	9/17/75	9/18/75
Time	Mtly	1535	1115	0825	0825
Temperature	Cent	12.5	12.0	9.0	8.5
pH	SU	7.7	7.8	7.3	7.4
Flow (USGS)	cfs	(20)	(20)	26.2*(19)	(18)
DO	mg/l	8.7	9.3	8.8	8.9
Conductivity	µmhos/cm	1040	940	980	970
Turbidity	FTU	3.9	3.1	3.2	2.5
Alkalinity (as $CaCO_3$)	mg/l	176	184	184	190
Hardness	mg/l	516	504	524	512
TDS	mg/l	718	720	732	744
TSS (Grab)	mg/l	14	14	17	14
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	1.1	1.1	1.1	1.1
Tot. Fluoride	mg/l	0.51	0.66	0.60	0.60
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	400	300	300	400
Tot. Boron	µg/l	200	210	500	300
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	124,000	134,000	124,000	124,000
Tot. Chromium	µg/l	20	10	20	<10
Tot. Copper	µg/l	14	<5	6	5
Tot. Iron	µg/l	280	270	280	240
Tot. Lead	µg/l	<5	<5	<5	<5
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	22,000	22,000	21,000	22,000
Tot. Manganese	µg/l	40	16	36	36
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1200	1100	1100	1100
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	3100	3000	3200	3100
Tot. Zinc	µg/l	35	45	35	20

* EPA flow measurement.

WHITE RIVER STUDY

Station No. WR-11

Parameter	Units	9/8/75	9/9/75	9/10/75	9/11/75
Time	Mtly	1550	1040	1100	0850
Temperature	Cent	11.0	8.0	9.0	6.5
pH	SU	7.7	7.5	7.2	7.2
Flow* (USGS)	cfs	(355)	(349)	(380)	(379)
DO	mg/l	8.6	9.1	8.8	9.1
Conductivity	µmhos/cm	370	370	370	370
Turbidity	FTU	0.81	1.0	5.5	2.1
Alkalinity (as $CaCO_3$)	mg/l	110	108	106	104
Hardness	mg/l	156	156	152	156
TDS	mg/l	250	240	220	228
TSS (Grab)	mg/l	-	4.8	17/17	9.0
TSS (Comp.)	mg/l	4.0/5.2	-	-	-
Tot. Chloride	mg/l	<1	1.0	<1	<1
Tot. Fluoride	mg/l	0.14	0.14	0.28	0.14
Tot. Arsenic	µg/l	13	11	<5	<5
Tot. Aluminum	µg/l	<200	200	<200	<200
Tot. Boron	µg/l	70	90	90	120
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	52,000	40,000	39,000	40,000
Tot. Chromium	µg/l	10	15	15	10
Tot. Copper	µg/l	6	<5	14	<5
Tot. Iron	µg/l	105	125	720	265
Tot. Lead	µg/l	8	6	<5	8
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	11,000	10,000	11,000	10,000
Tot. Manganese	µg/l	14	14	22	16
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1200	1200	1300	1200
Tot. Selenium	µg/l	<5	<5	<5	5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	2700	2500	2600	2600
Tot. Zinc	µg/l	35	25	65	150

* No flow measurement made. Flow would be approximately equal to the combined flows at BC-12, SF-13, and NF-15.

WHITE RIVER STUDY

Station No. BC-12

Parameter	Units	9/8/75	9/9/75	9/10/75	9/11/75
Time	Mtly	1615	1015	1040	0835
Temperature	Cent	15.0	10.0	11.5	8.0
pH	SU	7.8	7.7	7.3	7.4
Flow* (EPA)	cfs	-	3.9	-	-
DO	mg/l	9.8	9.8	9.9	8.7
Conductivity	µmhos/cm	760	820	780	820
Turbidity	FTU	0.92	0.69	0.96	0.87
Alkalinity (as $CaCO_3$)	mg/l	152	162	170	172
Hardness	mg/l	364	380	372	392
TDS	mg/l	524	530	496	558
TSS (Grab)	mg/l	2.6	4.4	1.2	4.4/5.2
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	1.2	1.3	1.9	1.4
Tot. Fluoride	mg/l	0.56	0.56	0.48	0.40
Tot. Arsenic	µg/l	6	<5	<5	5
Tot. Aluminum	µg/l	200	200	<200	<200
Tot. Boron	µg/l	<100	160	110	130
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	95,000	95,000	86,000	95,000
Tot. Chromium	µg/l	15	15	10	10
Tot. Copper	µg/l	<5	6	<5	6
Tot. Iron	µg/l	180	160	95	130
Tot. Lead	µg/l	8	8	<5	10
Tot. Lithium	µg/l	<25	25	<25	<25
Tot. Magnesium	µg/l	24,000	25,000	24,000	24,000
Tot. Manganese	µg/l	28	24	28	30
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	2000	1800	1700	1700
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	4800	4700	4400	4700
Tot. Zinc	µg/l	30	35	95	155

* Flows did not vary significantly from day to day.

WHITE RIVER STUDY

Station No. SF-13

Parameter	Units	9/8/75	9.9.75	9/10/75	9/11/75
Time	Mtly	1415	1055	1220	1030
Temperature	Cent	10.5	9.0	10.0	8.5
pH	SU	7.7	7.4	7.2	7.4
Flow* (USGS)	cfs	(139)	(137)	(143)	(135)
DO	mg/l	8.7	8.5	8.7	8.8
Conductivity	µmhos/cm	340	340	330	330
Turbidity	FTU	0.52	1.5	5.3	1.3
Alkalinity (as $CaCO_3$)	mg/l	120	122	116	120
Hardness	mg/l	148	140	136	140
TDS	mg/l	214	218	190	208
TSS (Grab)	mg/l	3.0	4.8	17	6.4
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	<1	1.3	<1	1.2
Tot. Fluoride	mg/l	0.14	<0.1	0.14	<0.1
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	<200	200	400	<200
Tot. Boron	µg/l	80	140	120	100
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	42,000	36,000	35,000	35,000
Tot. Chromium	µg/l	10	<10	10	15
Tot. Copper	µg/l	6	<5	6	<5
Tot. Iron	µg/l	85	115	470	130
Tot. Lead	µg/l	8	8	<5	10
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	11,000	11,000	9600	10,000
Tot. Manganese	µg/l	16	18	26	8
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1500	1100	1100	1000
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	2300	2100	2100	2200
Tot. Zinc	µg/l	20	15	105	150

* Flow data from USGS

WHITE RIVER STUDY

Station No. SF-14

Parameter	Units	9/8/75	9/9/75	9/10/75	9/11/75
Time	Mtly	1500	1130	1145	0930
Temperature	Cent	9.0	8.0	7.0	6.0
pH	SU	7.7	7.7	6.9	7.2
Flow* (EPA)	cfs	-	119	-	-
DO	mg/l	9.1	9.1	9.0	9.3
Conductivity	µmhos/cm	240	240	240	220
Turbidity	FTU	0.36	0.84	0.84	0.59
Alkalinity (as $CaCO_3$)	mg/l	102	98	116	102
Hardness	mg/l	104	92	116	92
TDS	mg/l	150	136	148	134
TSS (Grab)	mg/l	-	3.0	4.0	2.2
TSS (Comp.)	mg/l	1.4	-	-	-
Tot. Chloride	mg/l	1.1	<1	<1	<1
Tot. Fluoride	mg/l	<0.1	<0.1	0.24	<0.1
Tot. Arsenic	µg/l	9	<5	<5	<5
Tot. Aluminum	µg/l	<200	<200	<200	<200
Tot. Boron	µg/l	120	50	70	80
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	26,000	22,000	20,000	22,000
Tot. Chromium	µg/l	20	<10	<10	<10
Tot. Copper	µg/l	<5	<5	<5	6
Tot. Iron	µg/l	100	80	120	125
Tot. Lead	µg/l	<5	6	<5	8
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	10,000	8400	7600	8000
Tot. Manganese	µg/l	12	16	10	2
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1000	900	900	1000
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	1900	1900	1800	2000
Tot. Zinc	µg/l	20	15	150	100

* Flows did not vary significantly from day to day.

WHITE RIVER STUDY

Station No. NF-15

Parameter	Units	9/8/75	9/9/75	9/10/75	9/11/75
Time	Mtly	1350	1000	1020	1040
Temperature	Cent	9.5	7.0	8.0	7.5
pH	SU	7.1	7.4	7.2	7.2
Flow* (USGS)	cfs	(212)	(208)	(233)	(240)
DO	mg/l	8.9	10.0	9.0	9.3
Conductivity	µmhos/cm	370	390	360	360
Turbidity	FTU	1.1	1.5	1.1	1.8
Alkalinity (as $CaCO_3$)	mg/l	88	92	90	90
Hardness	mg/l	152	148	148	148
TDS	mg/l	246	226	230	230
TSS (Grab)	mg/l	-	8.4/8.6	6.6	8.6
TSS (Comp.)	mg/l	7.2/7.2	-	-	-
Tot. Chloride	mg/l	<1	<1	<1	<1
Tot. Fluoride	mg/l	0.14	0.26	0.12	<0.1
Tot. Arsenic	µg/l	7	<5	<5	<5
Tot. Aluminum	µg/l	<200	200	<200	250
Tot. Boron	µg/l	70	100	100	100
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	40,000	37,000	39,000	37,000
Tot. Chromium	µg/l	15	10	15	10
Tot. Copper	µg/l	8	10	6	10
Tot. Iron	µg/l	175	185	200	275
Tot. Lead	µg/l	20**	<5	6	8
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	11,000	11,000	9600	9200
Tot. Manganese	µg/l	22	20	18	14
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1200	1200	1200	1300
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	2800	2700	2700	2700
Tot. Zinc	µg/l	30	20	100	80

* Flow data from USGS

** High value possibly due to contaminated glassware

WHITE RIVER STUDY

Station No. LC-16

Parameter	Units	9/8/75	9/9/75	9/10/75	9/11/75
Time	Mtly	1645	0925	0955	1105
Temperature	Cent	12.5	8.0	9.0	9.5
pH	SU	7.9	7.5	7.3	7.6
Flow* (USGS)	cfs	(2.4)	(2.6)	(3.4)	(4.3)
DO	mg/l	9.0	8.8	<8.5	8.9
Conductivity	µmhos/cm	490	500	460	400
Turbidity	FTU	0.85	1.2	0.88	2.3
Alkalinity (as $CaCO_3$)	mg/l	146	154	150	140
Hardness	mg/l	188	204	188	164
TDS	mg/l	304	282	338	238
TSS (Grab)	mg/l	1.4	4.8	1.8/2.2	5.0
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	<1	<1	<1	1.4
Tot. Fluoride	mg/l	0.26	0.12	<0.1	0.10
Tot. Arsenic	µg/l	13	7	<5	<5
Tot. Aluminum	µg/l	<200	200	<200	<200
Tot. Boron	µg/l	130	160	120	130
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	50,000	51,000	50,000	40,000
Tot. Chromium	µg/l	10	10	15	10
Tot. Copper	µg/l	6	10	16	6
Tot. Iron	µg/l	95	90	105	160
Tot. Lead	µg/l	6	6	6	6
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	14,000	14,000	13,000	12,000
Tot. Manganese	µg/l	16	28	22	18
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1400	1500	1400	1400
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	8000	8300	8000	7700
Tot. Zinc	µg/l	25	15	180	110

* Flow data from USGS

WHITE RIVER STUDY

Station No. NF-17

Parameter	Units	9/8/75	9/9/75	9/10/75	9/11/75
Time	Mtly	1700	0855	0930	1120
Temperature	Cent	10.0	6.0	6.0	8.0
pH	SU	7.3	6.9	7.2	7.3
Flow* (EPA)	cfs	-	129	-	-
DO	mg/l	8.5	9.1	8.9	8.8
Conductivity	µmhos/cm	320	320	320	300
Turbidity	FTU	18	0.85	0.77	1.1
Alkalinity (as $CaCO_3$)	mg/l	78	76	82	76
Hardness	mg/l	124	128	128	128
TDS	mg/l	200	208	198	254
TSS (Grab)	mg/l	67	6.6	5.0	
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	<1	<1	<1	<1
Tot. Fluoride	mg/l	0.14	0.20	0.12	0.10
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	2000	200	<200	450
Tot. Boron	µg/l	60	120	100	70
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	37,000	31,000	33,000	31,000
Tot. Chromium	µg/l	45	<10	10	<10
Tot. Copper	µg/l	8	10	6	<5
Tot. Iron	µg/l	2500	190	195	205
Tot. Lead	µg/l	8	<5	8	8
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	9000	8800	8000	8000
Tot. Manganese	µg/l	44	18	14	12
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1400	1100	1100	1100
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	2700	2500	2500	2700
Tot. Zinc	µg/l	35	15	145	210

* Flows did not vary significantly from day to day.

WHITE RIVER STUDY

Station No. NF-18

Parameter	Units	9/8/75	9/9/75	9/10/75	9/11/75
Time	Mtly	1735	0800	0900	1200
Temperature	Cent	6.0	5.0	5.0	6.0
pH	SU	7.5	7.3	7.2	7.3
Flow* (EPA)	cfs	-	30.8	-	-
DO	mg/l	8.3	8.6	8.4	8.6
Conductivity	µmhos/cm	150	120	120	140
Turbidity	FTU	0.72	0.35	0.53	0.65
Alkalinity (as $CaCO_3$)	mg/l	58	54	56	56
Hardness	mg/l	48	48	52	48
TDS	mg/l	90	196	96	110
TSS (Grab)	mg/l	2.4	2.0/2.8	2.4	3.0
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	<1	<1	<1	<1
Tot. Fluoride	mg/l	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	<200	200	<200	<200
Tot. Boron	µg/l	60	50	70	70
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	12,000	10,000	12,000	12,000
Tot. Chromium	µg/l	20	<10	10	<10
Tot. Copper	µg/l	6	<5	6	<5
Tot. Iron	µg/l	125	110	135	150
Tot. Lead	µg/l	6	<5	10	6
Tot. Lithium	µg/l	<25	<25	<25	<25
Tot. Magnesium	µg/l	5600	4800	4800	4800
Tot. Manganese	µg/l	14	22	14	12
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	1100	1100	1000	1100
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	1800	1700	1700	1800
Tot. Zinc	µg/l	25	20	180	70

* Flows did not vary significantly from day to day.

WHITE RIVER STUDY

Station No. MC-19

Parameter	Units	9/15/75	9/16/75	9/17/75	9/18/75
Time	Mtly	1255	0855	1145	1045
Temperature	Cent	12.0	13.0	15.5	13.5
pH	SU	7.6	7.4	7.8	8.0
Flow* (EPA)	cfs	-	-	0.9	-
DO	mg/l	7.3	7.1	7.0	6.9
Conductivity	µmhos/cm	750	700	730	730
Turbidity	FTU	26	26	22	20
Alkalinity (as $CaCO_3$)	mg/l	208	208	210	220
Hardness	mg/l	296	304	312	328
TDS	mg/l	468	466	482	480
TSS (Grab)	mg/l	46	41	36	31
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	5.3	5.0	5.0	5.3
Tot. Fluoride	mg/l	0.31	0.36	0.12	0.12
Tot. Arsenic	µg/l	<5	<5	<5	5
Tot. Aluminum	µg/l	1250	1300	900	1200
Tot. Boron	µg/l	220	170	350	200
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	70,000	65,000	71,000	71,000
Tot. Chromium	µg/l	10	20	10	10
Tot. Copper	µg/l	8	8	8	6
Tot. Iron	µg/l	1240	1200	1150	1150
Tot. Lead	µg/l	5	<5	<5	<5
Tot. Lithium	µg/l	35	25	25	50
Tot. Magnesium	µg/l	24,000	25,000	25,000	26,000
Tot. Manganese	µg/l	155	86	90	104
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	3400	3100	3000	3200
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	21,000	18,000	20,000	22,000
Tot. Zinc	µg/l	30	40	70	35

* Flows did not vary significantly from day to day.

WHITE RIVER STUDY

Station No. MC-20

Parameter	Units	9/15/75	9/16/75	9/17/75	9/18/75
Time	Mtly	1330	0925	1100	1010
Temperature	Cent	20.0	13.0	12.0	12.5
pH	SU	7.8	7.8	8.0	8.0
Flow* (EPA)	cfs	-	-	3.3	-
DO	mg/l	7.8	8.3	8.0	8.7
Conductivity	µmhos/cm	1420	1200	1470	1530
Turbidity	FTU	3.7	7.3	4.3	3.5
Alkalinity (as $CaCO_3$)	mg/l	322	336	328	336
Hardness	mg/l	636	676	652	684
TDS	mg/l	1110	1070	1110	1170
TSS (Grab)	mg/l	12	26	11	9.6
TSS (Comp.)	mg/l	-	-	-	-
Tot. Chloride	mg/l	1.8	1.3	1.3	<1
Tot. Fluoride	mg/l	0.52	0.52	0.59	0.59
Tot. Arsenic	µg/l	<5	<5	<5	<5
Tot. Aluminum	µg/l	250	350	200	300
Tot. Boron	µg/l	280	290	<100	250
Tot. Cadmium	µg/l	<5	<5	<5	<5
Tot. Calcium	µg/l	81,000	82,000	83,000	82,000
Tot. Chromium	µg/l	<10	25	10	<10
Tot. Copper	µg/l	10	12	<5	6
Tot. Iron	µg/l	310	560	300	340
Tot. Lead	µg/l	<5	<5	5	<5
Tot. Lithium	µg/l	85	60	55	50
Tot. Magnesium	µg/l	85,000	85,000	85,000	85,000
Tot. Manganese	µg/l	70	94	80	92
Tot. Molybdenum	µg/l	<10	<10	<10	<10
Tot. Potassium	µg/l	5700	5200	5100	4900
Tot. Selenium	µg/l	<5	<5	<5	<5
Tot. Silver	µg/l	<5	<5	<5	<5
Tot. Sodium	µg/l	64,000	61,000	64,000	75,000
Tot. Zinc	µg/l	30	25	30	10

* Flows did not vary significantly from day to day.

APPENDIX B

DATA FROM THE SPRING, 1976

"HIGH FLOW" STUDY

WHITE RIVER STUDY

Station No. WR-1

Parameter	Units	5/24/76	5/25/76	5/26/76	5/27/76
Time	Mtly	1420	0925	0905	0915
Temperature	Cent	14.5	12.0	12.0	13.5
pH	SU	7.1	7.5	7.6	7.0
Flow*	cfs	1814	1714	1484	1404
DO	mg/ℓ	8.4	8.6	8.7	8.4
Conductivity	µmhos/cm	400	415	450	460
Turbidity	FTU	165	160	150	130
Alkalinity (as $CaCO_3$)	mg/ℓ	151	149	139	147
Hardness	mg/ℓ	160	164	176	176
TDS	mg/ℓ	242	154	270	274
TSS (Grab)	mg/ℓ	680	672	600	528
TSS (Comp.)	mg/ℓ	-	-	-	532
Tot. Chloride	mg/ℓ	10	11	11	12
Tot. Fluoride	mg/ℓ	0.15	0.14	0.15	0.16
Tot. Arsenic	µg/ℓ	5	10	10	10
Tot. Aluminum	µg/ℓ	10250	11550	10050	7300
Tot. Boron	µg/ℓ	170	170	190	150
Tot. Cadmium	µg/ℓ	6	14	8	10
Tot. Calcium	µg/ℓ	33500	31500	31500	28500
Tot. Chromium	µg/ℓ	10	15	10	10
Tot. Copper	µg/ℓ	20	25	15	20
Tot. Iron	µg/ℓ	13000	13000	13000	11500
Tot. Lead	µg/ℓ	10	15	10	10
Tot. Lithium	µg/ℓ	35	20	25	20
Tot. Magnesium	µg/ℓ	18000	18000	20000	19000
Tot. Manganese	µg/ℓ	295	335	320	235
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	4000	4200	4500	3900
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	5	5	<5
Tot. Sodium	µg/ℓ	18000	18000	21000	23000
Tot. Zinc	µg/ℓ	130	60	70	35
TKN	mg/ℓ	2.32	1.37	2.16	1.86
NO_2 + NO_3 - N	mg/ℓ	0.20	0.18	0.16	0.16
NH_3 - N	mg/ℓ	0.01	0.01	0.01	0.02
Total-P	mg/ℓ	0.772	0.542	0.768	0.440
Ortho-P	mg/ℓ	0.043	0.051	0.034	0.043

*Flow equals White River flow measured by USGS at gaging station located 4.7 miles upstream from Rangely, Colorado plus flow contribution from Douglas Creek (54 cfs measured by EPA on 5/27/76).

WHITE RIVER STUDY

Station No. WR-2

Parameter	Units	5/24/76	5/25/76	5/26/76	5/27/76
Time	Mtly	1500	1035	1025	1050
Temperature	Cent	13.0	11.0	12.0	13.5
pH	SU	7.1	7.1	7.2	7.0
Flow* (USGS)	cfs	(1760)	(1660)	(1430)	(1350)
DO	mg/ℓ	8.7	8.8	8.9	8.5
Conductivity	µmhos/cm	370	400	430	440
Turbidity	FTU	78	53	54	52
Alkalinity (as $CaCO_3$)	mg/ℓ	114	120	123	133
Hardness	mg/ℓ	148	156	156	164
TDS	mg/ℓ	220	136	256	256
TSS (Grab)	mg/ℓ	222	174	147	146
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	10	11	11	12
Tot. Fluoride	mg/ℓ	0.13	0.13	0.14	0.14
Tot. Arsenic	µg/ℓ	<5	<5	<5	5
Tot. Aluminum	µg/ℓ	4650	3100	3625	2800
Tot. Boron	µg/ℓ	125	110	100	100
Tot. Cadmium	µg/ℓ	6	8	8	<5
Tot. Calcium	µg/ℓ	23500	23500	23500	40000
Tot. Chromium	µg/ℓ	<10	10	<10	<10
Tot. Copper	µg/ℓ	20	10	5	10
Tot. Iron	µg/ℓ	5000	3500	3750	2950
Tot. Lead	µg/ℓ	<5	5	<5	<5
Tot. Lithium	µg/ℓ	20	15	15	15
Tot. Magnesium	µg/ℓ	12000	13000	13000	13000
Tot. Manganese	µg/ℓ	125	100	85	75
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	2200	1900	2300	1900
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	10	<5	<5
Tot. Sodium	µg/ℓ	15000	17000	19000	19000
Tot. Zinc	µg/ℓ	110	50	5	15
TKN	mg/ℓ	1.69	1.00	0.18	0.56
$NO_2 + NO_3 - N$	mg/ℓ	0.15	0.15	0.14	0.12
NH_3 -N	mg/ℓ	0.01	0.02	0.01	0.02
Total-P	mg/ℓ	0.268	0.191	0.184	0.194
Ortho-P	mg/ℓ	0.041	0.038	0.030	0.034

*Flow was not measured due to the proximity of this station with the USGS gaging station located 4.7 miles upstream from Rangely. Value shown is USGS measurement at the station located 4.7 miles upstream from Rangely

WHITE RIVER STUDY

Station No. YC-3

Parameter	Units	5/24/76	5/25/76	5/26/76	5/27/76
Time	Mtly	1520	1105	1045	1115
Temperature	Cent	18.5	18.5	16.0	20.0
pH	SU	8.5	8.7	8.75	8.5
Flow* (USGS)	cfs	(1.7)	(1.6)	(1.5)	(1.4)
DO	mg/ℓ	2.8	4.1	5.2	3.8
Conductivity	µmhos/cm	4000	4100	4400	4100
Turbidity	FTU	43	33	18	23
Alkalinity (as $CaCO_3$)	mg/ℓ	1595	1555	1575	1630
Hardness	mg/ℓ	568	556	576	564
TDS	mg/ℓ	2648	2646	2818	2730
TSS (Grab)	mg/ℓ	111	94	59	50
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	152	152	172	128
Tot. Fluoride	mg/ℓ	2.35	2.30	2.35	2.35
Tot. Arsenic	µg/ℓ	10	10	10	10
Tot. Aluminum	µg/ℓ	2400	2000	1100	1250
Tot. Boron	µg/ℓ	975	1035	1095	1000
Tot. Cadmium	µg/ℓ	12	14	12	12
Tot. Calcium	µg/ℓ	16000	18000	17000	24000
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	10	10	10	10
Tot. Iron	µg/ℓ	1700	1350	800	850
Tot. Lead	µg/ℓ	5	<5	<5	<5
Tot. Lithium	µg/ℓ	240	200	220	230
Tot. Magnesium	µg/ℓ	110000	110000	110000	105000
Tot. Manganese	µg/ℓ	45	35	20	30
Tot. Molybdenum	µg/ℓ	24	22	26	28
Tot. Potassium	µg/ℓ	13000	11000	12000	12000
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	5	5	10
Tot. Sodium	µg/ℓ	715000	728000	755000	820000
Tot. Zinc	µg/ℓ	10	5	<5	<5
TKN	mg/ℓ	2.82	1.78	1.71	1.35
NO_2 + NO_3 - N	mg/ℓ	0.01	0.17	0.26	0.23
NH_3 - N	mg/ℓ	0.02	<0.01	<0.01	0.02
Total-P	mg/ℓ	0.121	0.079	0.058	0.064
Ortho-P	mg/ℓ	0.021	0.015	0.014	0.016

*Flow data from USGS.

WHITE RIVER STUDY

Station No. WR-4

Parameter	Units	5/24/76	5/25/76	5/26/76	5/27/76
Time	Mtly	1535	1125	1100	1130
Temperature	Cent	11.0	11.5	11.0	13.5
pH	SU	7.2	7.8	7.8	7.6
Flow* (USGS)	cfs	(1752)	(1607)	(1538)	(1516)
DO	mg/ℓ	8.8	8.6	9.3	8.9
Conductivity	µmhos/cm	370	395	420	405
Turbidity	FTU	81	39	38	35
Alkalinity (as $CaCO_3$)	mg/ℓ	114	118	122	123
Hardness	mg/ℓ	140	160	160	168
TDS	mg/ℓ	224	287	254	238
TSS (Grab)	mg/ℓ	176	116	93	100
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	10	11	9.2	11
Tot. Fluoride	mg/ℓ	0.12	0.13	0.15	0.14
Tot. Arsenic	µg/ℓ	<5	<5	5	<5
Tot. Aluminum	µg/ℓ	4000	2500	3150	1850
Tot. Boron	µg/ℓ	140	105	125	100
Tot. Cadmium	µg/ℓ	6	<5	6	<5
Tot. Calcium	µg/ℓ	22500	23500	23500	40000
Tot. Chromium	µg/ℓ	<10	10	<10	<10
Tot. Copper	µg/ℓ	10	10	5	<5
Tot. Iron	µg/ℓ	4100	2600	2300	2150
Tot. Lead	µg/ℓ	5	<5	<5	<5
Tot. Lithium	µg/ℓ	15	15	15	15
Tot. Magnesium	µg/ℓ	11000	12000	12000	12000
Tot. Manganese	µg/ℓ	80	65	55	55
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	2000	1800	1900	1800
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	5	5	5	<5
Tot. Sodium	µg/ℓ	14000	14000	18000	17000
Tot. Zinc	µg/ℓ	20	10	<5	70
TKN	mg/ℓ	0.75	1.18	0.34	0.44
$NO_2 + NO_3 - N$	mg/ℓ	0.14	0.12	0.12	0.10
$NH_3 - N$	mg/ℓ	0.02	0.01	0.01	0.01
Total-P	mg/ℓ	-	0.146	0.127	0.123
Ortho-P	mg/ℓ	0.045	0.035	0.029	0.033

*Flow assumed equal to the sum of USGS-measured flows at Station WR-5 plus flow in Piceance Creek.

WHITE RIVER STUDY

Station No. WR-5

Parameter	Units	5/24/76	5/25/76	5/26/75	5/27/76
Time	Mtly	1605	1155	1130	1155
Temperature	Cent	10.0	11.0	10.0	12.5
pH	SU	7.25	7.4	7.7	7.5
Flow* (USGS)	cfs	(1740)	(1590)	(1520)	(1500)
DO	mg/ℓ	8.9	9.2	9.6	9.1
Conductivity	µmhos/cm	340	350	360	340
Turbidity	FTU	23	26	27	26
Alkalinity (as $CaCO_3$)	mg/ℓ	100	108	110	106
Hardness	mg/ℓ	148	148	148	136
TDS	mg/ℓ	202	214	228	204
TSS (Grab)	mg/ℓ	72	86	71	76
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	8.2	8.2	9.5	11
Tot. Fluoride	mg/ℓ	0.10	0.11	0.12	0.11
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	1800	1650	1750	1950
Tot. Boron	µg/ℓ	125	140	115	80
Tot. Cadmium	µg/ℓ	12	6	6	6
Tot. Calcium	µg/ℓ	23000	22000	21500	38000
Tot. Chromium	µg/ℓ	10	<10	<10	10
Tot. Copper	µg/ℓ	10	10	<5	<5
Tot. Iron	µg/ℓ	2050	1950	1900	1900
Tot. Lead	µg/ℓ	<5	5	<5	<5
Tot. Lithium	µg/ℓ	15	15	10	10
Tot. Magnesium	µg/ℓ	9800	10400	10600	9900
Tot. Manganese	µg/ℓ	50	50	40	45
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	1600	1600	1600	1700
Tot. Selenium	µg/ℓ	<5	<5	<5	5
Tot. Silver	µg/ℓ	5	<5	<5	<5
Tot. Sodium	µg/ℓ	9000	8100	10000	9000
Tot. Zinc	µg/ℓ	5	20	10	<5
TKN	mg/ℓ	0.66	0.46	0.46	1.54
$NO_2 + NO_3 - N$	mg/ℓ	0.14	0.12	0.12	0.10
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.117	0.123	0.106	0.115
Ortho-P	mg/ℓ	0.027	0.028	0.026	0.028

*Flow data from USGS

WHITE RIVER STUDY

Station No. WR-6

Parameter	Units	5/31/76	6/1/76	6/2/76	6/3/76
Time	Mtly	1240	0825	1000	1010
Temperature	Cent	10.5	9.0	10.0	10.0
pH	SU	7.4	7.0	7.2	7.2
Flow* (USGS)	cfs	(2360)	(2260)	(2480)	(2500)
DO	mg/ℓ	9.4	9.3	9.2	9.5
Conductivity	µmhos/cm	290	300	280	270
Turbidity	FTU	17	8.6	22	17
Alkalinity (as $CaCO_3$)	mg/ℓ	94	94	90	88
Hardness	mg/ℓ	124	120	116	112
TDS	mg/ℓ	180	162	156	160
TSS (Grab)	mg/ℓ	44.5	47.5	83	54
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	7.4	8.5	7.2	7.2
Tot. Fluoride	mg/ℓ	<0.10	<0.10	<0.10	<0.10
Tot. Arsenic	µg/ℓ	<5	<5	5	<5
Tot. Aluminum	µg/ℓ	1300	1450	2550	1600
Tot. Boron	µg/ℓ	130	175	80	125
Tot. Cadmium	µg/ℓ	6	6	<5	<5
Tot. Calcium	µg/ℓ	30500	30500	28500	28500
Tot. Chromium	µg/ℓ	<10	10	<10	10
Tot. Copper	µg/ℓ	5	<5	10	5
Tot. Iron	µg/ℓ	1200	1300	2500	1550
Tot. Lead	µg/ℓ	<5	<5	<5	<5
Tot. Lithium	µg/ℓ	10	10	10	10
Tot. Magnesium	µg/ℓ	8800	8800	8600	8000
Tot. Manganese	µg/ℓ	30	40	50	40
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	1100	1400	1500	1000
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	6400	6400	5500	6700
Tot. Zinc	µg/ℓ	20	20	10	10
TKN	mg/ℓ	0.82	0.52	0.16	0.56
$NO_2 + NO_3 - N$	mg/ℓ	0.13	0.10	0.09	0.10
$NH_3 - N$	mg/ℓ	0.01	0.02	0.01	0.01
Total-P	mg/ℓ	0.084	0.086	0.123	0.113
Ortho-P	mg/ℓ	0.022	0.022	0.023	0.024

*Flow assumed to be similar to USGS flow measurements at station located 2.5 miles upstream from Meeker, Colorado.

WHITE RIVER STUDY

Station No. CC-8

Parameter	Units	5/31/76	6/1/76	6/2/76	6/3/76
Time	Mtly	1215	1120	1100	1115
Temperature	Cent	12.0	12.5	16.0	13.5
pH	SU	7.3	7.4	7.2	7.3
Flow (EPA)	cfs	-	17.3	-	16.0
DO	mg/ℓ	8.4	8.4	8.3	8.2
Conductivity	µmhos/cm	510	500	550	555
Turbidity	FTU	89	84	64	62
Alkalinity (as $CaCO_3$)	mg/ℓ	141	143	153	157
Hardness	mg/ℓ	216	220	244	244
TDS	mg/ℓ	338	300	346	350
TSS (Grab)	mg/ℓ	318	282	65	148
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	7.7	6.2	6.7	6.9
Tot. Fluoride	mg/ℓ	0.13	0.11	0.12	0.12
Tot. Arsenic	µg/ℓ	5	15	10	5
Tot. Aluminum	µg/ℓ	5900	5300	3400	3050
Tot. Boron	µg/ℓ	65	225	170	165
Tot. Cadmium	µg/ℓ	6	6	6	8
Tot. Calcium	µg/ℓ	65000	46000	50000	50000
Tot. Chromium	µg/ℓ	10	10	10	<10
Tot. Copper	µg/ℓ	20	10	10	5
Tot. Iron	µg/ℓ	6250	5250	3800	3450
Tot. Lead	µg/ℓ	5	5	<5	<5
Tot. Lithium	µg/ℓ	25	25	25	25
Tot. Magnesium	µg/ℓ	21000	21000	23000	23000
Tot. Manganese	µg/ℓ	135	120	80	85
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	3000	2900	2900	2600
Tot. Selenium	µg/ℓ	10	5	10	10
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	12000	11000	13000	13000
Tot. Zinc	µg/ℓ	30	25	20	20
TKN	mg/ℓ	1.31	1.05	0.45	0.81
$NO_2 + NO_3 - N$	mg/ℓ	0.40	0.31	0.30	0.32
$NH_3 - N$	mg/ℓ	0.02	0.02	0.01	0.01
Total -P	mg/ℓ	0.285	0.286	0.212	0.219
Ortho-P	mg/ℓ	0.058	0.057	0.059	0.080

WHITE RIVER STUDY

Station No. LBC-9

Parameter	Units	5/31/76	6/1/76	6/2/76	6/3/76
Time	Mtly	1200	1105	1050	1100
Temperature	Cent	15.0	14.0	15.0	16.0
pH	SU	7.0	7.3	7.2	7.2
Flow* (EPA)	cfs	-	3.1	-	6.5
DO	mg/ℓ	8.6	8.4	8.2	8.0
Conductivity	μmhos/cm	1040	1000	820	740
Turbidity	FTU	15	24	25	26
Alkalinity (as $CaCO_3$)	mg/ℓ	198	198	170	157
Hardness	mg/ℓ	492	456	364	324
TDS	mg/ℓ	717	646	538	506
TSS (Grab)	mg/ℓ	20	68	72	50
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	15	15	12	10
Tot. Fluoride	mg/ℓ	0.18	0.18	0.17	0.15
Tot. Arsenic	μg/ℓ	5	10	10	5
Tot. Aluminum	μg/ℓ	650	1150	1150	1250
Tot. Boron	μg/ℓ	270	320	250	200
Tot. Cadmium	μg/ℓ	6	8	8	8
Tot. Calcium	μg/ℓ	120000	105000	97500	68000
Tot. Chromium	μg/ℓ	10	<10	15	<10
Tot. Copper	μg/ℓ	10	10	10	5
Tot. Iron	μg/ℓ	850	1250	1350	1300
Tot. Lead	μg/ℓ	<5	<5	<5	<5
Tot. Lithium	μg/ℓ	55	45	40	35
Tot. Magnesium	μg/ℓ	49000	41000	33000	28000
Tot. Manganese	μg/ℓ	85	115	80	60
Tot. Molybdenum	μg/ℓ	<10	<10	<10	<10
Tot. Potassium	μg/ℓ	5300	5400	5000	3700
Tot. Selenium	μg/ℓ	30	30	20	15
Tot. Silver	μg/ℓ	<5	<5	5	<5
Tot. Sodium	μg/ℓ	30000	28000	22000	19000
Tot. Zinc	μg/ℓ	10	10	25	15
TKN	mg/ℓ	1.43	2.17	1.92	1.34
$NO_2 + NO_3 - N$	mg/ℓ	0.84	1.16	0.53	0.31
$NH_3 - N$	mg/ℓ	0.18	0.64	0.26	0.13
Total-P	mg/ℓ	0.313	0.648	0.376	0.340
Ortho-P	mg/ℓ	0.242	0.408	0.260	0.235

*Variable irrigation diversions and return flows affect flow at this location.

WHITE RIVER STUDY

Station No. MC-10

Parameter	Units	5/31/76	6/1/76	6/2/76	6/3/76
Time	Mtly	1315	1230	1120	1145
Temperature	Cent	14.0	13.5	12.0	14.0
pH	SU	7.6	7.5	7.5	7.6
Flow* (USGS)	cfs	(21)	(20)	(18)	(17)
DO	mg/ℓ	8.6	8.9	9.1	8.9
Conductivity	μmhos/cm	720	760	790	800
Turbidity	FTU	3.1	2.5	2.4	2.1
Alkalinity (as $CaCO_3$)	mg/ℓ	159	161	165	170
Hardness	mg/ℓ	372	396	408	428
TDS	mg/ℓ	490	500	527	562
TSS (Grab)	mg/ℓ	25	11	16	6.8
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	1.3	1.5	1.8	2.0
Tot. Fluoride	mg/ℓ	0.28	0.28	0.28	0.30
Tot. Arsenic	μg/ℓ	<5	10	5	<5
Tot. Aluminum	μg/ℓ	400	300	250	250
Tot. Boron	μg/ℓ	290	210	205	190
Tot. Cadmium	μg/ℓ	8	6	6	6
Tot. Calcium	μg/ℓ	100000	110000	140000	140000
Tot. Chromium	μg/ℓ	<10	<10	<10	<10
Tot. Copper	μg/ℓ	15	10	15	<5
Tot. Iron	μg/ℓ	350	300	300	150
Tot. Lead	μg/ℓ	<5	<5	<5	<5
Tot. Lithium	μg/ℓ	15	15	15	15
Tot. Magnesium	μg/ℓ	14000	14000	15000	16000
Tot. Manganese	μg/ℓ	10	10	10	10
Tot. Molybdenum	μg/ℓ	<10	<10	<10	<10
Tot. Potassium	μg/ℓ	1000	1000	1100	800
Tot. Selenium	μg/ℓ	<5	5	<5	<5
Tot. Silver	μg/ℓ	<5	<5	<5	<5
Tot. Sodium	μg/ℓ	1100	1500	2400	2900
Tot. Zinc	μg/ℓ	5	<5	5	<5
TKN	mg/ℓ	0.14	0.04	0.67	0.31
$NO_2 + NO_3 - N$	mg/ℓ	0.56	0.54	0.52	0.49
$NH_3 - N$	mg/ℓ	0.01	<0.01	<0.01	<0.01
Total-P	mg/ℓ	0.021	0.016	0.016	0.012
Ortho-P	mg/ℓ	0.007	0.009	0.001	0.003

*Flow data from USGS.

WHITE RIVER STUDY

Station No. WR-11

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1240	1115	1100	1100
Temperature	Cent	9.5	9.0	9.0	8.5
pH	SU	7.2	7.35	7.4	7.1
Flow* (USGS)	cfs	-	(2108)	-	(1848)
DO	mg/ℓ	9.5	9.6	9.6	9.6
Conductivity	µmhos/cm	190	185	185	180
Turbidity	FTU	4.1	4.2	5.2	5.9
Alkalinity (as $CaCO_3$)	mg/ℓ	82	80	78	76
Hardness	mg/ℓ	96	80	84	76
TDS	mg/ℓ	109	134	104	110
TSS (Grab)	mg/ℓ	19	19	18	20
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	1.0	1.5	0.8	1.3
Tot. Fluoride	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	750	600	550	650
Tot. Boron	µg/ℓ	75	90	155	80
Tot. Cadmium	µg/ℓ	6	8	8	<5
Tot. Calcium	µg/ℓ	21500	19500	21000	21000
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	5	5	5	10
Tot. Iron	µg/ℓ	775	650	525	700
Tot. Lead	µg/ℓ	<5	<5	5	<5
Tot. Lithium	µg/ℓ	<10	<10	<10	<10
Tot. Magnesium	µg/ℓ	6200	5600	5800	5400
Tot. Manganese	µg/ℓ	15	15	15	10
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	700	800	600	800
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	5	<5	<5	<5
Tot. Sodium	µg/ℓ	1500	2400	1500	1500
Tot. Zinc	µg/ℓ	15	10	5	5
TKN	mg/ℓ	0.83	0.16	0.47	0.58
$NO_2 + NO_3 - N$	mg/ℓ	0.07	0.06	0.06	0.05
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.046	0.054	0.046	0.054
Ortho-P	mg/ℓ	0.011	0.014	0.012	0.015

*No flow measurement made. Flow is assumed to be approximately equal to the combined flows at BC-12, SF-13, and NF-15.

WHITE RIVER STUDY

Station No. BC-12

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1225	1140	1115	1120
Temperature	Cent	15.5	15.0	14.5	15.0
pH	SU	7.0	7.4	7.3	7.4
Flow (EPA)	cfs	-	17.4	-	14.4
DO	mg/ℓ	8.3	8.9	7.9	9.0
Conductivity	µmhos/cm	360	340	410	430
Turbidity	FTU	4.5	5.2	3.6	2.7
Alkalinity (as $CaCO_3$)	mg/ℓ	116	104	126	134
Hardness	mg/ℓ	168	148	184	204
TDS	mg/ℓ	230	210	250	274
TSS (Grab)	mg/ℓ	11	12	8	6
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	1.6	1.0	2.1	1.5
Tot. Fluoride	mg/ℓ	0.14	0.14	0.16	0.16
Tot. Arsenic	µg/ℓ	<5	5	<5	<5
Tot. Aluminum	µg/ℓ	250	300	100	200
Tot. Boron	µg/ℓ	110	125	135	155
Tot. Cadmium	µg/ℓ	5	6	8	6
Tot. Calcium	µg/ℓ	405000	38500	45000	55000
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	<5	<5	10	<5
Tot. Iron	µg/ℓ	325	375	325	200
Tot. Lead	µg/ℓ	<5	<5	<5	<5
Tot. Lithium	µg/ℓ	10	10	15	15
Tot. Magnesium	µg/ℓ	10200	8800	11000	13000
Tot. Manganese	µg/ℓ	25	25	20	20
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	900	1000	1200	1100
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	4400	3400	3700	3800
Tot. Zinc	µg/ℓ	10	30	10	<5
TKN	mg/ℓ	0.12	0.02	0.55	0.47
$NO_2 + NO_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.021	0.031	0.021	0.016
Ortho-P	mg/ℓ	0.009	0.011	0.010	0.011

WHITE RIVER STUDY

Station No. SF-13

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1245	1105	1050	1045
Temperature	Cent	8.5	8.0	8.0	8.0
pH	SU	7.2	7.2	7.1	7.0
Flow* (USGS)	cfs	(1450)	(1330)	(1200)	(1080)
DO	mg/ℓ	9.3	9.5	9.6	9.5
Conductivity	µmhos/cm	190	180	180	170
Turbidity	FTU	4.1	4.1	5.2	6.7
Alkalinity (as $CaCO_3$)	mg/ℓ	82	82	80	76
Hardness	mg/ℓ	48	80	80	72
TDS	mg/ℓ	106	107	98	98
TSS (Grab)	mg/ℓ	16	17	18	18
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	0.3	1.8	1.0	1.5
Tot. Fluoride	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	600	450	550	700
Tot. Boron	µg/ℓ	90	100	95	95
Tot. Cadmium	µg/ℓ	<5	<5	6	<5
Tot. Calcium	µg/ℓ	21000	20500	21000	20000
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	<5	<5	5	<5
Tot. Iron	µg/ℓ	550	525	600	675
Tot. Lead	µg/ℓ	<5	<5	<5	<5
Tot. Lithium	µg/ℓ	<10	<10	<10	<10
Tot. Magnesium	µg/ℓ	6000	5400	5800	5200
Tot. Manganese	µg/ℓ	15	15	10	15
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	800	800	600	400
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	3200	2300	900	900
Tot. Zinc	µg/ℓ	15	10	5	<5
TKN	mg/ℓ	0.09	0.06	0.52	0.69
$NO_2 + NO_3 - N$	mg/ℓ	0.07	0.07	0.06	0.05
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.048	0.061	0.047	0.052
Ortho-P	mg/ℓ	0.010	0.012	0.012	0.013

*Flow data from USGS.

WHITE RIVER STUDY

Station No. SF-14

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1325	1025	1015	1015
Temperature	Cent	8.5	6.5	6.0	6.3
pH	SU	7.1	7.1	7.0	7.1
Flow* (USGS)	cfs	(1240)	(1220)	(1200)	(1190)
DO	mg/ℓ	9.4	9.9	10.0	10.0
Conductivity	µmhos/cm	165	160	155	150
Turbidity	FTU	2.5	2.3	2.8	2.2
Alkalinity (as $CaCO_3$)	mg/ℓ	76	74	70	70
Hardness	mg/ℓ	76	72	80	64
TDS	mg/ℓ	82	90	87	86
TSS (Grab)	mg/ℓ	8	8	6	8
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	0.3	0.5	1.3	1.5
Tot. Fluoride	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	300	250	300	300
Tot. Boron	µg/ℓ	60	90	100	95
Tot. Cadmium	µg/ℓ	<5	6	6	<5
Tot. Calcium	µg/ℓ	18500	17500	17500	17500
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	<5	<5	10	<5
Tot. Iron	µg/ℓ	225	275	200	275
Tot. Lead	µg/ℓ	<5	5	<5	5
Tot. Lithium	µg/ℓ	<10	<10	<10	<10
Tot. Magnesium	µg/ℓ	5400	4800	5200	4800
Tot. Manganese	µg/ℓ	5	5	<5	20
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	600	700	700	600
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	2200	2100	1900	1500
Tot. Zinc	µg/ℓ	15	10	15	<5
TKN	µg/ℓ	0.14	0.51	0.47	1.47
$NO_2 + NO_3 - N$	mg/ℓ	0.06	0.07	0.08	0.05
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.027	0.036	0.025	0.028
Ortho-P	mg/ℓ	0.008	0.010	0.012	0.011

*Flow measured by USGS at gaging station located 5.6 miles southeast of Buford, Colorado.

WHITE RIVER STUDY

Station No. NF-15

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1210	0950	0940	0935
Temperature	Cent	10.5	8.0	9.0	8.0
pH	SU	6.7	7.0	6.9	7.0
Flow* (USGS)	cfs	(747)	(761)	(761)	(754)
DO	mg/ℓ	9.2	9.4	9.4	9.4
Conductivity	µmhos/cm	180	185	180	185
Turbidity	FTU	5.4	5.3	6.1	5.8
Alkalinity (as $CaCO_3$)	mg/ℓ	56	56	56	56
Hardness	mg/ℓ	76	80	76	76
TDS	mg/ℓ	122	121	112	124
TSS (Grab)	mg/ℓ	24	25	22	21
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	1.0	1.3	2.1	1.5
Tot. Fluoride	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	750	800	800	700
Tot. Boron	µg/ℓ	60	105	115	140
Tot. Cadmium	µg/ℓ	<5	<5	6	<5
Tot. Calcium	µg/ℓ	19500	19500	19500	20000
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	<5	10	15	<5
Tot. Iron	µg/ℓ	750	950	800	750
Tot. Lead	µg/ℓ	<5	5	<5	5
Tot. Lithium	µg/ℓ	<10	<10	<10	<10
Tot. Magnesium	µg/ℓ	5200	4600	5000	5000
Tot. Manganese	µg/ℓ	25	25	20	20
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	800	900	1000	800
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	1500	2800	3100	2700
Tot. Zinc	µg/ℓ	10	5	5	10
TKN	mg/ℓ	0.62	0.24	0.55	0.52
$NO_2 + NO_3 - N$	mg/ℓ	0.05	0.05	0.05	0.05
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.066	0.057	0.067	0.068
Ortho-P	mg/ℓ	0.018	0.016	0.017	0.019

*Flow data from USGS.

WHITE RIVER STUDY

Station No. LC-16

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1145	0920	0915	0910
Temperature	Cent	12.0	9.0	9.51	8.5
pH	SU	6.8	6.9	6.8	6.8
Flow* (USGS)	cfs	(30)	(27)	(26)	(22)
DO	mg/ℓ	8.6	9.2	8.8	9.2
Conductivity	µmhos/cm	185	190	190	190
Turbidity	FTU	9.1	8.2	8.8	9.1
Alkalinity (as $CaCO_3$)	mg/ℓ	74	74	72	74
Hardness	mg/ℓ	120	84	80	80
TDS	mg/ℓ	116	124	118	132
TSS (Grab)	mg/ℓ	15	14	14	11
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	1.4	0.2	2.1	2.4
Tot. Fluoride	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	450	300	450	450
Tot. Boron	µg/ℓ	110	115	90	80
Tot. Cadmium	µg/ℓ	6	8	8	6
Tot. Calcium	µg/ℓ	20000	20500	21000	21000
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	<5	5	20	<5
Tot. Iron	µg/ℓ	575	550	550	575
Tot. Lead	µg/ℓ	<5	5	5	<5
Tot. Lithium	µg/ℓ	<10	<10	<10	<10
Tot. Magnesium	µg/ℓ	4600	4400	4600	4600
Tot. Manganese	µg/ℓ	10	10	10	10
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	900	700	1000	800
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	3800	3300	3900	3500
Tot. Zinc	µg/ℓ	10	5	<5	5
TKN	mg/ℓ	0.39	0.25	0.46	0.40
$NO_2 + NO_3 - N$	mg/ℓ	0.01	0.01	0.01	<0.01
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.039	0.034	0.035	0.033
Ortho-P	mg/ℓ	0.014	0.014	0.016	0.016

*Flow data from USGS.

WHITE RIVER STUDY

Station No. NF-17

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1130	0910	0905	0900
Temperature	Cent	10.0	7.5	8.0	7.5
pH	SU	6.5	6.7	6.7	6.7
Flow*	cfs	-	-	-	-
DO	mg/ℓ	9.0	9.4	9.3	9.4
Conductivity	µmhos/cm	145	150	150	150
Turbidity	FTU	5.2	4.1	3.5	4.6
Alkalinity (as $CaCO_3$)	mg/ℓ	48	46	48	46
Hardness	mg/ℓ	60	60	60	60
TDS	mg/ℓ	98	96	94	94
TSS(Grab)	mg/ℓ	20	20	16	16
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	0.8	1.3	1.5	1.3
Tot. Fluoride	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	550	550	550	600
Tot. Boron	µg/ℓ	100	100	115	75
Tot. Cadmium	µg/ℓ	<5	6	8	<5
Tot. Calcium	µg/ℓ	15500	15000	15500	15500
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	<5	10	20	<5
Tot. Iron	µg/ℓ	725	600	550	575
Tot. Lead	µg/ℓ	<5	5	<5	<5
Tot. Lithium	µg/ℓ	<10	<10	<10	<10
Tot. Magnesium	µg/ℓ	4400	3800	4000	3800
Tot. Manganese	µg/ℓ	20	15	10	20
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	900	700	700	700
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	2000	2800	2500	2200
Tot. Zinc	µg/ℓ	10	10	15	20
TKN	mg/ℓ	0.35	0.37	0.27	0.40
$NO_2 + NO_3 - N$	mg/ℓ	0.04	0.05	0.04	0.03
$NH_3 - N$	mg/ℓ	0.01	<0.01	0.01	0.01
Total-P	mg/ℓ	0.056	0.057	0.056	0.053
Ortho-P	mg/ℓ	0.016	0.018	0.017	0.018

*No flow measurements possible at this location due to high water.

WHITE RIVER STUDY

Station No. NF-18

Parameter	Units	6/7/76	6/8/76	6/9/76	6/10/76
Time	Mtly	1100	0825	0835	0820
Temperature	Cent	8.5	7.0	8.0	8.0
pH	SU	6.8	6.5	6.4	6.6
Flow (EPA)	cfs	-	216	-	228
DO	mg/ℓ	8.6	8.8	8.7	8.7
Conductivity	µmhos/cm	100	95	90	90
Turbidity	FTU	0.75	1.3	2.4	1.3
Alkalinity (as $CaCO_3$)	mg/ℓ	40	42	42	38
Hardness	mg/ℓ	36	36	36	32
TDS	mg/ℓ	64	62	52	58
TSS (Grab)	mg/ℓ	6	6	4	4
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	<0.10	1.0	1.3	1.8
Tot. Fluoride	mg/ℓ	<0.1	<0.1	<0.1	<0.1
Tot. Arsenic	µg/ℓ	<5	<5	<5	<5
Tot. Aluminum	µg/ℓ	100	150	<100	150
Tot. Boron	µg/ℓ	45	90	65	30
Tot. Cadmium	µg/ℓ	6	6	<5	6
Tot. Calcium	µg/ℓ	8750	8500	9000	8000
Tot. Chromium	µg/ℓ	<10	<10	<10	<10
Tot. Copper	µg/ℓ	<5	10	5	5
Tot. Iron	µg/ℓ	200	200	200	175
Tot. Lead	µg/ℓ	<5	<5	<5	<5
Tot. Lithium	µg/ℓ	<10	<10	<10	<10
Tot. Magnesium	µg/ℓ	2800	3000	3000	2800
Tot. Manganese	µg/ℓ	10	20	5	30
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	900	600	600	700
Tot. Selenium	µg/ℓ	<5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	1500	2200	1900	1500
Tot. Zinc	µg/ℓ	10	5	10	5
TKN	mg/ℓ	1.79	0.36	1.40	0.01
$NO_2 + NO_3 - N$	mg/ℓ	0.08	0.06	0.05	0.04
$NH_3 - N$	mg/ℓ	0.01	0.01	0.01	0.01
Total-P	mg/ℓ	0.036	0.026	0.026	0.023
Ortho-P	mg/ℓ	0.026	0.017	0.018	0.016

WHITE RIVER STUDY

Station No. MC-19

Parameter	Units	5/31/76	6/1/76	6/2/76	6/3/76
Time	Mtly	1130	1005	0830	0820
Temperature	Cent	11.0	10.0	9.5	10.0
pH	SU	6.7	7.4	6.9	6.8
Flow (EPA)	cfs	-	52	-	49.5
DO	mg/ℓ	8.7	8.9	8.6	8.5
Conductivity	µmhos/cm	400	400	400	430
Turbidity	FTU	40	58	76	46
Alkalinity (as $CaCO_3$)	mg/ℓ	125	129	125	137
Hardness	mg/ℓ	172	176	176	200
TDS	mg/ℓ	236	248	252	274
TSS (Grab)	mg/ℓ	105	144	153	108
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	3.3	3.3	3.3	4.1
Tot. Fluoride	mg/ℓ	0.13	0.12	0.12	0.13
Tot. Arsenic	µg/ℓ	5	10	5	<5
Tot. Aluminum	µg/ℓ	1750	2950	3650	2600
Tot. Boron	µg/ℓ	170	195	110	190
Tot. Cadmium	µg/ℓ	<5	6	<5	6
Tot. Calcium	µg/ℓ	41000	41500	42000	41000
Tot. Chromium	µg/ℓ	<10	<10	10	<10
Tot. Copper	µg/ℓ	5	15	10	5
Tot. Iron	µg/ℓ	2300	3200	4050	3050
Tot. Lead	µg/ℓ	<5	<5	<5	<5
Tot. Lithium	µg/ℓ	20	20	25	25
Tot. Magnesium	µg/ℓ	13000	13000	13000	14000
Tot. Manganese	µg/ℓ	40	50	65	80
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	2200	1500	2800	2300
Tot. Selenium	µg/ℓ	5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	<5	<5
Tot. Sodium	µg/ℓ	9500	8500	10000	11000
Tot. Zinc	µg/ℓ	50	15	25	20
TKN	mg/ℓ	0.61	0.38	1.42	0.65
$NO_2 + NO_3 - N$	mg/ℓ	0.06	0.06	0.05	0.04
$NH_3 - N$	mg/ℓ	0.01	0.02	0.01	0.01
Total-P	mg/ℓ	0.084	0.111	0.145	0.106
Ortho-P	mg/ℓ	0.024	0.025	0.027	0.019

WHITE RIVER STUDY

Station No. MC-20

Parameter	Units	5/31/76	6/1/76	6/2/76	6/3/76
Time	Mtly	1055	0915	0900	0900
Temperature	Cent	13.0	13.0	14.0	13.5
pH	SU	6.9	7.2	7.2	7.2
Flow* (EPA)	cfs	-	36.2	-	22.3
DO	mg/ℓ	8.5	8.1	8.1	8.0
Conductivity	µmhos/cm	550	600	650	690
Turbidity	FTU	85	75	88	66
Alkalinity (as $CaCO_3$)	mg/ℓ	153	170	180	186
Hardness	mg/ℓ	240	260	284	300
TDS	mg/ℓ	320	378	416	440
TSS (Grab)	mg/ℓ	244	208	234	154
TSS (Comp.)	mg/ℓ	-	-	-	-
Tot. Chloride	mg/ℓ	4.3	4.4	5.8	5.9
Tot. Fluoride	mg/ℓ	0.15	0.15	0.18	0.17
Tot. Arsenic	µg/ℓ	5	10	5	5
Tot. Aluminum	µg/ℓ	4500	3750	4450	3500
Tot. Boron	µg/ℓ	165	255	220	235
Tot. Cadmium	µg/ℓ	8	6	6	6
Tot. Calcium	µg/ℓ	50000	41250	72000	75000
Tot. Chromium	µg/ℓ	10	15	10	<10
Tot. Copper	µg/ℓ	15	10	15	5
Tot. Iron	µg/ℓ	5750	5000	5500	4350
Tot. Lead	µg/ℓ	5	5	5	<5
Tot. Lithium	µg/ℓ	35	30	40	35
Tot. Magnesium	µg/ℓ	21000	23000	27000	27000
Tot. Manganese	µg/ℓ	150	75	100	75
Tot. Molybdenum	µg/ℓ	<10	<10	<10	<10
Tot. Potassium	µg/ℓ	3900	3800	3800	3700
Tot. Selenium	µg/ℓ	5	<5	<5	<5
Tot. Silver	µg/ℓ	<5	<5	5	<5
Tot. Sodium	µg/ℓ	16000	16000	22000	21000
Tot. Zinc	µg/ℓ	30	25	30	30
TKN	mg/ℓ	0.61	0.37	0.86	1.23
$NO_2 + NO_3 - N$	mg/ℓ	0.09	0.10	0.09	0.09
$NH_3 - N$	mg/ℓ	0.05	0.01	0.01	0.01
Total-P	mg/ℓ	0.209	0.176	0.197	0.151
Ortho-P	mg/ℓ	0.030	0.024	0.025	0.022

*Variable irrigation diversions and return flows affect flow at this location.